NRFOSQ-ESH-EE-14-028

Naval Reactors Facility

ENVIRONMENTAL MONITORING REPORT

Calendar Year 2013

Prepared for the
U. S. Department of Energy
By Bechtel Marine Propulsion Corporation

2013 ENVIRONMENTAL MONITORING REPORT

FOR THE

NAVAL REACTORS FACILITY (NRF)

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY BY

BECHTEL MARINE PROPULSION CORPORATION
BETTIS ATOMIC POWER LABORATORY
NAVAL REACTORS FACILITY

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LIST OF ACRONYMS

A1W	Large Ship Reactor Prototype
ACM	Asbestos Containing Material
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CAP-88	Clean Air Act Assessment Package-1988
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRQL	Contract Laboratory Program Required Quantitation Limit
DLC	Decision Level Concentration
DOE	Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
ECF	Expended Core Facility
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EHS	Extremely Hazardous Substance
ERA	Environmental Resource Associates
FFA/CO	Federal Facility Agreement and Consent Order
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GHG	Greenhouse Gas
HAP	Hazardous Air Pollutant
HEPA	High Efficiency Particulate Air
IDEQ	Idaho Department of Environmental Quality
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IWD	Industrial Waste Ditch
LDR	Land Disposal Restrictions
LEPC	Local Emergency Planning Committee
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MDL	Minimum Detection Level
mg/L	Milligrams per liter
MSDS/SDS	Material Safety Data Sheet/Safety Data Sheet
NAICS	North American Industry Classification System
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priorities List

LIST OF ACRONYMS (Cont.)

NO_X	Nitrogen Oxides
NRF	Naval Reactors Facility
O&M	Operation and Maintenance
OSLD	Optically Stimulated Luminescence Dosimeter
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PCM	Phase Contrast Microscopy
PM	Particulate Matter
PM_{10}	Particulate Matter less than or equal to 10 micrometers
QL	Quantitation Limit
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
S1W	Submarine Thermal Reactor Prototype
S5G	Advanced Water Cooled Natural Circulation Submarine Prototype
SERC	State Emergency Response Commission
SMCL	Secondary Maximum Contaminant Level
SOC	Semi-volatile Organic Compound
SO_2	Sulfur Dioxide
SO_X	Sulfur Oxide
STP	Site Treatment Plan
SWDA	Solid Waste Disposal Act
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TEM	Transmission Electron Microscopy
TLD	Thermo Luminescent Dosimeter
TPQ	Threshold Planning Quantity
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TDS	Total Dissolved Solids
TSD	Treatment, Storage, and Disposal (Facility)
U.S.	United States
USGS	United States Geological Survey
VOC	Volatile Organic Compound

1 EXECUTIVE SUMMARY

This report presents the results of the radiological and nonradiological environmental monitoring programs for 2013 at the Naval Reactors Facility (NRF). Current operations at NRF are in compliance with applicable regulations governing use, emission, and disposal of solid, liquid, and gaseous materials. The results obtained from the environmental monitoring programs verify that releases to the environment from operations at NRF were in accordance with federal and state regulations. Evaluation of the environmental data confirms that the operation of NRF continues to have no adverse effect on the quality of the environment or the health and safety of the general public. Furthermore, a conservative assessment of radiation exposure to the general public as a result of NRF operations demonstrated that the maximum potential dose received by any member of the public was well below the most restrictive dose limits prescribed by the United States (U.S.) Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE).

The results of the radiological and nonradiological environmental monitoring programs for the NRF are summarized below.

Definitions for technical terms used in this report can be found in the Glossary, Section 8.

Liquid Releases (Other than to Sanitary Sewer)

Approximately 5.4 million gallons of water were released to the environment via the Industrial Waste Ditch (IWD). No radioactivity attributable to operations at the NRF site was detected in any of the environmental samples from these releases. Radioactivity concentrations were typical of natural background levels in water from the Snake River Plain Aquifer. Monitoring data for chemical and radiological constituents of liquid wastewater effluents continued to demonstrate compliance with DOE and applicable federal and state regulations, including NRF's Industrial Reuse Permit.

Sanitary Sewer Discharges

All sanitary effluents are discharged to NRF's evaporative sewage lagoon. No radioactivity attributable to operations at the NRF site was detected in any of the environmental samples of sanitary waste. All wastes discharged to the sanitary system were in compliance with applicable regulations.

Drinking Water Monitoring

Analysis of water from drinking water wells collected onsite did not detect any radioactivity in excess of natural background levels. All required nonradiological drinking water monitoring results were below regulatory limits, demonstrating compliance with all applicable regulations.

Groundwater Monitoring

Strontium-90 and program-specific gamma emitting nuclides measured in samples collected from groundwater well groups located onsite and offsite were typical of natural background levels. Measurements for tritium radioactivity were at least two orders of magnitude below drinking water standards. All of the (monitored or target) nonradiological constituent concentrations were below primary drinking water standards. Groundwater monitoring wells are not used for drinking water

supply; therefore, drinking water standards are used as references or guidelines only. Monitoring data continues to demonstrate compliance with all applicable regulations.

Soil Gas Monitoring

Results from the soil gas analysis for volatile organic compounds indicate that several constituents were detected at or above the sample quantitation limit. However, the constituents were detected within the range of previously detected concentrations and were significantly below action limits. In addition, based on risk assessments performed for these sites under previous Comprehensive Environmental Response, Compensation, and Liability Act investigations, the levels detected for all constituents do not pose a significant threat to the environment.

Airborne Effluent

Airborne radioactivity in NRF effluents was controlled using high efficiency particulate air filters and, in some cases, charcoal filters to maintain particulate and gaseous radioactivity releases as low as reasonably achievable. The results of NRF's airborne radiological effluent monitoring have shown that the amount of radioactivity released was too small to result in any measurable change in the background radioactivity levels in the environment. Therefore, the concentrations of the particulate and gaseous radioactivity released from the NRF site were well within the applicable standards for radioactivity in the environment.

Emissions of nonradiological air effluents were calculated and recorded according to the Tier I Air Permit. No visible emissions were observed above regulatory limits. All emissions of nonradiological air effluents were well below applicable EPA and State of Idaho standards. Monitoring data continues to demonstrate compliance with all applicable regulations.

Soil and Vegetation Monitoring

Although some low levels of radioactivity are present in the soil at some localized areas at NRF as a result of past operations, this radioactivity does not present a significant risk to onsite personnel, the general public, or the environment. These areas are monitored on a routine basis to verify that radioactivity is not migrating and to ensure that the risk remains insignificant. Therefore, NRF operations did not contribute to any measurable increase in the radioactivity of the surrounding environment.

Control of Wastes

Hazardous materials were neither manufactured nor disposed of at the NRF site. However, hazardous wastes were generated during site operations. Onsite wastes were handled, controlled, and stored by trained personnel in accordance with all applicable federal and state regulations. Offsite disposal is arranged with licensed treatment, storage, and disposal facilities. The volume of solid, low-level radioactive waste was minimized by limiting the type and amount of materials that could become contaminated. All solid low-level radioactive waste shipped offsite was packaged in containers meeting U.S. Department of Transportation requirements. Procedures and practices for controlling wastes continue to ensure compliance with all applicable regulations.

Radiation Monitoring

Both NRF and the Idaho National Laboratory (INL) independently performed measurements of radiation along the NRF security fence. Comparing the average reading along the NRF security fence and the average background reading measured by NRF at non-developed locations on the INL five to ten miles away from NRF, indicates that NRF did not contribute to a detectable increase in radiation levels. Monitoring data continues to demonstrate compliance with all applicable regulations.

Radiological Dose Assessment

Radiation exposure to the general public from NRF airborne releases was too low to measure and could only be estimated using conservative EPA approved computer modeling. Direct exposure to the public as a result of NRF operations was also too low to measure. The resultant evaluation of all exposure pathways conservatively estimated a maximum annual dose of 0.00038 millirem to an individual offsite. This dose is substantially below the radiation exposure limits of 100 millirem per year established by the Nuclear Regulatory Commission and the DOE (References 1 and 2). Further, it is negligible when compared to the naturally occurring background radiation dose of approximately 366 millirem per year calculated in southeast Idaho. It is also much less than the approximate 3 millirem that an individual could receive from a single cross-country airplane flight.

Conclusion

Operations at the NRF site during 2013 did not result in any significant release of radioactivity or hazardous materials to the environment. In addition, operations did not have any adverse effect on human health or the quality of the environment at the site or in the surrounding communities.

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2 INTRODUCTION

The Naval Reactors Facility (NRF) is operated for the U.S. Naval Nuclear Propulsion Program by Bechtel Marine Propulsion Corporation, Bettis Atomic Power Laboratory-Idaho. It is located on the Idaho National Laboratory (INL) site 6.7 miles from the nearest INL boundary (Figure 1). The developed portion of the facility within the security fence covers approximately 84 of the 4,400 acres under the cognizance of NRF. Most of the INL site, including NRF, is not accessible to the general public.

The continuing primary mission of NRF includes the design, development, testing, and operational follow of nuclear reactor propulsion plants for naval surface and submarine vessels. Specifically, NRF exists to support this nation's capability to deploy and maintain a modern nuclear Navy. NRF supports the United States nuclear fleet operations and development needs by providing the Naval Nuclear Propulsion Program with unique fuel processing capabilities and accurate and timely nuclear examination data.

Three former naval reactor prototypes and the Expended Core Facility (ECF) are located within the NRF security fence (Figure 2). The S1W, A1W, and S5G prototypes were shut down in October 1989, January 1994, and May 1995, respectively.

Developmental nuclear fuel material samples, naval spent fuel, and irradiated reactor plant components/materials are examined at ECF. The knowledge gained from these examinations is used to improve current designs and to monitor the performance of existing reactors. The examination of naval spent fuel performed at ECF is critical to the design of longer-lived cores, which results in the creation of less spent fuel requiring disposition. NRF is also preparing spent naval nuclear fuel for dry storage. Over the past 50+ years, the Naval Nuclear Propulsion Program has safely shipped over 800 containers of spent nuclear fuel without injury to a member of the public or a release of radioactivity to the public.

The purpose of this report is to summarize the NRF environmental monitoring program results for calendar year 2013. This report also evaluates current operations at NRF and documents compliance with applicable regulations governing use, emission, and disposal of solid, liquid, and gaseous materials.

2.1 GEOLOGICAL AND DEMOGRAPHIC SITE DESCRIPTION

The NRF site is located on a 4,400 acre parcel of land within the boundaries of the INL. The INL is comprised of 894 square miles extending across the northeast portion of the Snake River Plain, which covers parts of Butte, Jefferson, Bingham, Clark, and Bonneville counties in Idaho. The Snake River Plain is a U-shaped plateau approximately 300 miles long and 50 to 70 miles wide. Within its land area of 12,000 square miles, the plain descends from an elevation of 6,000 feet in the east, near Ashton, Idaho, to 2,300 feet in the west, near Boise, Idaho. The plain is naturally bordered on all sides by mountains, some exceeding 12,000 feet in elevation.

The NRF site is underlain by a succession of inter-layered flows of basaltic lava. These lava flows form layers of hard rock varying in thickness from 10 to 100 feet. These layers are interspersed with layers of sedimentary materials of various depths. The Snake River Plain Aquifer lies

approximately 385 feet below the land surface. Groundwater within the aquifer generally flows to the south and west.

Located in a semi-arid desert environment, NRF has an average daily summer temperature of 64.8 degrees Fahrenheit and an average daily winter temperature of 20.8 degrees Fahrenheit. Precipitation at NRF averages less than 9 inches annually, and prevailing winds are out of the southwest (Reference 3).

The largest urban areas surrounding the INL include Pocatello to the southeast and Idaho Falls to the east. Both cities are approximately 50 air miles from NRF. Several small farming communities are located on the western, northwestern, and southeastern boundaries of the INL. Approximately 157,000 people live within a 50-mile radius of NRF according to the 2010 census data.

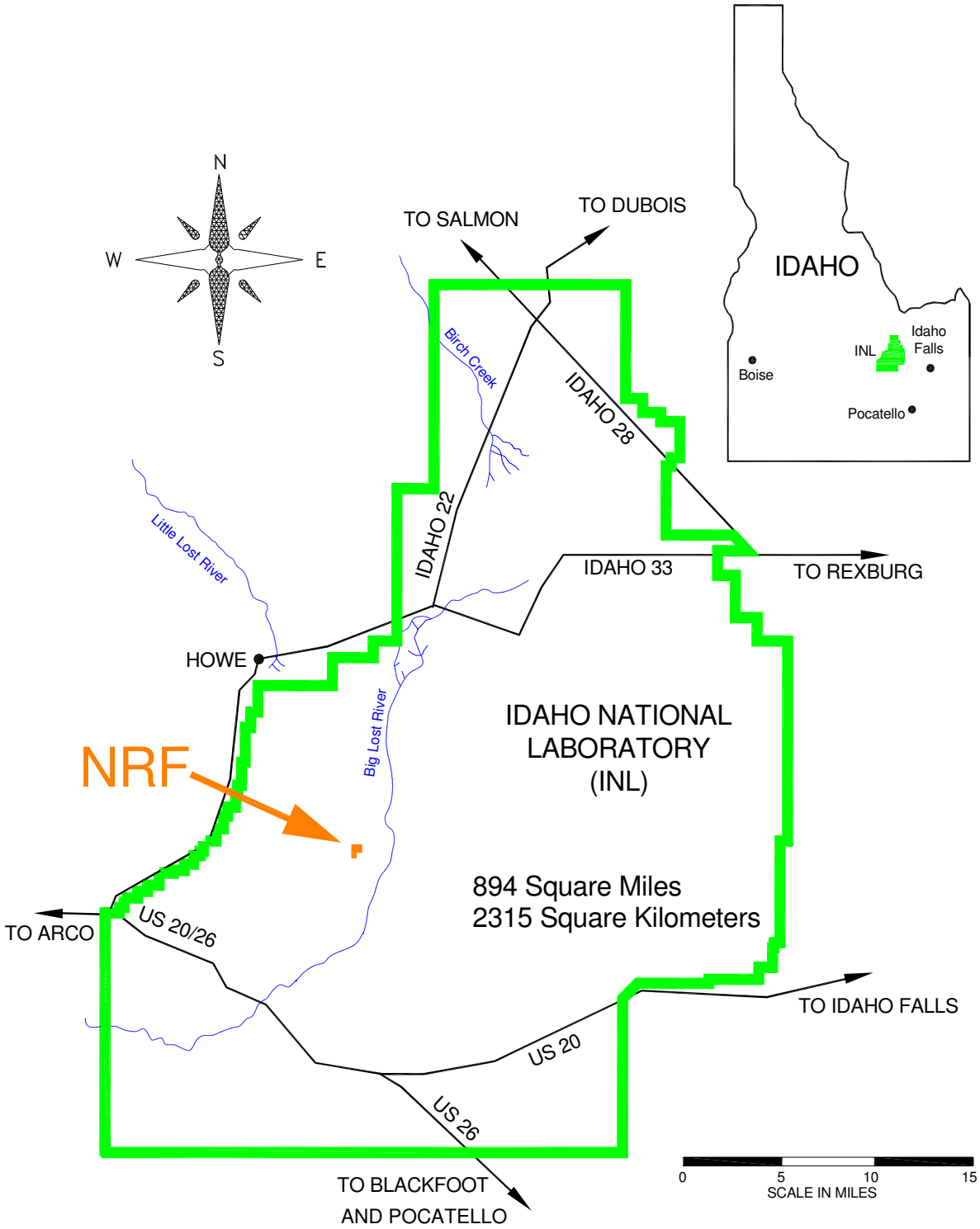

Figure 1 – Relation of NRF to the INL

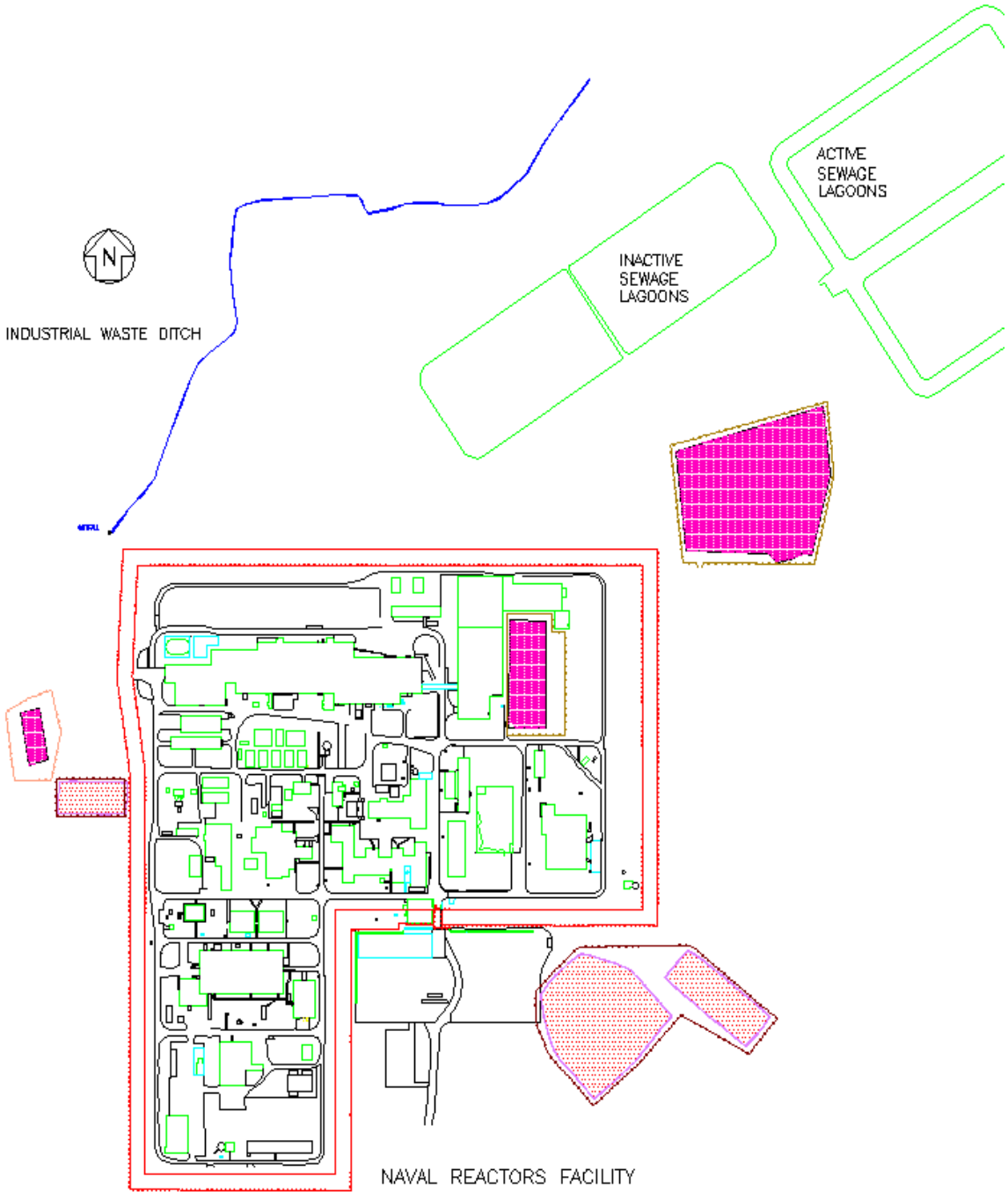

Figure 2 – The Naval Reactors Facility

3 ENVIRONMENTAL PROGRAM AND COMPLIANCE SUMMARY

3.1 ENVIRONMENTAL PROGRAM POLICY

NRF is committed to conducting operations and activities in a manner that provides and maintains safe and healthful working conditions, protects the environment and the public, and conserves natural resources. NRF is committed to environmental excellence through compliance with all applicable federal, state, and local regulations; proactive planning to integrate sound environmental, safety, and health principles; and a solid commitment to waste minimization and pollution prevention.

Objectives

The objectives of the NRF environmental monitoring program are to:

- Demonstrate compliance with regulatory requirements;
- Demonstrate site operations do not significantly impact the environment;
- Confirm the effectiveness of control methods in preventing increases in environmental radioactivity levels;
- Confirm that the potential radiation exposure received by a member of the public is insignificant compared to the dose received from natural background radioactivity;
- Provide accurate monitoring results to applicable federal, state, and local officials and to the general public;
- Notify appropriate regulatory agencies of potential compliance concerns; and
- Maintain an accurate record of NRF's effluent releases to the environment.

Organization

NRF employs environmental professionals who are responsible for identifying, interpreting, and communicating environmental requirements to NRF personnel for implementation; assisting NRF organizations in meeting their environmental responsibilities; monitoring environmental activities for compliance; interfacing with regulatory agencies; and completing required regulatory reports.

3.2 ENVIRONMENTAL, SAFETY, AND HEALTH MANAGEMENT SYSTEM

The Environmental, Safety, and Health Management System documents the management processes and systems to perform work in a manner protective of employees, the public, and the environment, while ensuring regulatory compliance. Environmental performance objectives, performance measurements, and commitments are prepared and reviewed annually. The management processes and systems are used to identify, communicate, implement, assess, and update environmental programs.

3.3 ENVIRONMENTAL COMPLIANCE

Compliance with environmental regulations is an integral program objective and is essential for successful facility operations. Compliance with environmental regulations is demonstrated by several methods. For example, federal, state, and local regulatory personnel periodically perform site visits and compliance inspections. During 2013, two site visits/inspections were performed at NRF by federal, state, or local agencies. A list of the inspections/visits and regulatory concerns, if any, is shown in Table 1. These inspections/visits did not identify any noncompliant issues. Questions or deficiencies identified during these inspections were immediately addressed or promptly corrected.

Table 1– Summary of Inspections/Visits by Regulatory Agencies

Agency	Area Inspected/Visited	Date	Results
Idaho Department of Environmental Quality	Hazardous waste storage areas	5-2-13	Hazardous waste compliance inspection of waste storage areas. No deficiencies were noted.
Idaho Department of Environmental Quality	Industrial Waste Ditch	9-17-13	Inspected the Industrial Waste Ditch and discussed items regarding the Industrial Reuse Permit. No deficiencies were noted.

There were no federal, state, or local Notices of Violation or other types of enforcement actions issued to NRF in 2013.

Internally, compliance is evaluated during environmental audits and evaluations performed by elements of the Naval Nuclear Propulsion Program, NRF's Site Assessment Organization, and by self-assessments performed by professionals in the NRF's Environmental Engineering organization and other site personnel (e.g., technicians, engineers, and managers).

Compliance with requirements is also demonstrated by effluent and environmental monitoring results. These results are discussed in this report.

Compliance is also demonstrated in many of the environmental reports prepared each year. A number of environmental related reports were submitted to federal, state, and local agencies during the year.

NRF operated under three environmental permits in 2013 that were issued from regulatory agencies for the specific facilities and/or operations. These permits are shown in Table 2.

NRF must meet all applicable environmental laws and regulations. A description of NRF's environmental compliance with key environmental regulations is provided below.

Table 2 – NRF Environmental Permits

Permit Number	Permit Type	Issuing Agency	In Compliance	Expiration Date	Other Information
T1-2009.0148	Air Quality Tier I Operating Permit	IDEQ(1)	Yes	2/06/2018(2)	Tier I/Title V Operating Permit 2/6/2013
WRU-I-0155-02	Industrial Reuse Permit	IDEQ	Yes	7/26/2012(3)	Industrial Waste Ditch
MB 04294B-0	Federal Fish and Wildlife Permit	U.S. Fish and Wildlife	Yes	3/31/16	Migratory Bird Permit

(1) State of Idaho Department of Environmental Quality (IDEQ) permit issued to the INL, which includes NRF.

(2) The INL submitted an application to IDEQ for permit renewal in 2009. IDEQ determined that the application materials were complete. Therefore, NRF operated under the previous permit until the new permit was issued by IDEQ on February 6, 2013.

(3) Prior to expiration, NRF submitted an application to renew this permit. IDEQ received this application and instructed NRF to continue to operate under the existing permit until IDEQ can complete the renewal process and issue an updated permit.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918, as amended, is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. Under this act, taking, killing, or possessing migratory birds is unlawful unless and except as permitted by regulation.

NRF is subject to a special purpose federal fish and wildlife permit that allows the removal or relocation of a limited number of migratory bird nests under certain circumstances. The permit was issued to the DOE and is applicable to all facilities on the INL. The permit requires DOE to submit an annual report to the U.S. Fish and Wildlife Service of all migratory birds, nests, and eggs that were intentionally taken and/or salvaged. NRF provides DOE with information about permit activity which occurs at NRF for inclusion in the report.

Clean Air Act (CAA)

The Clean Air Act (CAA) was originally passed in 1955 to protect and enhance the quality of the nation's air resources. The CAA was completely replaced by the Air Quality Act of 1967, although the name “Clean Air Act” was retained. However, these laws did not have control or enforcement strategies.

Amendments adopted in 1970 created by the EPA set ambient air quality standards and controls for emissions from stationary, mobile, and new stationary sources. These amendments also control hazardous air pollutants. Amendments adopted in 1977 established a standard basis for rulemaking regarding criteria for national ambient air quality standards, new source performance standards, hazardous air pollutant standards, motor vehicle standards, fuel and fuel-additive provisions, and aircraft emission standards.

The Clean Air Act Amendments of 1990 comprehensively revised existing U.S. air laws to provide for the attainment and maintenance of national ambient air quality. The 1990 amendments revised ozone and carbon monoxide classifications and pollutant control strategies for urban areas, tightened vehicular emission standards, required the production of clean-fuel vehicles, reformulated gasoline, mandated the regulation of new and existing sources of 189 hazardous air pollutants, developed maximum achievable control technologies, required reductions of power plant sulfur dioxide emissions, developed utility emission standards for nitrogen oxides, called for the establishment of a new permit system for major sources that consolidates all applicable emission control requirements, and mandated a production phase-out of the five most destructive ozone-depleting chemicals by 2000. These amendments also strengthened EPA and state civil and criminal enforcement powers to address violations of the CAA.

The regulatory authority for the majority of the CAA regulations that affect the NRF site has been delegated by the EPA to the Idaho Department of Environmental Quality (IDEQ). Non-radiological air emission sources at NRF are regulated under the IDEQ Air Permitting Program. Specific requirements to demonstrate CAA compliance are listed under the INL Title V Operating Permit relative to operation of various pieces of equipment and recordkeeping at NRF. In addition, point source emissions (e.g., from stacks, roof vents, and emergency generator exhaust stacks) must also meet visible emission requirements of the permit.

The EPA, under the Code of Federal Regulations (CFR) 40 CFR 61 Subpart H, regulates radionuclide air emission sources in Idaho. The results of NRF's airborne radiological effluent monitoring for 2013 have shown that the amount of radioactivity released at NRF was too small to result in any measurable change in the background radioactivity levels in the environment. Annual emission reports are provided to the EPA, as required by the regulations.

EPA enacted Mandatory Reporting of Greenhouse Gases regulations in 2009 (40 CFR 98). NRF identified one source category, “Stationary Combustion Sources”, which applies to the data collection and reporting requirements. NRF participates with the INL in preparation of this report. The INL issues an annual site-wide report that includes information from NRF.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA), an amendment to the Solid Waste Disposal Act of 1965, was enacted in 1976 to address the safe disposal of municipal and industrial solid and hazardous wastes.

The goals set by RCRA are to:

- Protect human health and the environment from the hazards posed by waste disposal;
- Conserve energy and natural resources through waste recycling and recovery;
- Reduce or eliminate, as expeditiously as possible, the amount of waste generated, including hazardous waste; and
- Ensure management of wastes in a manner that is protective of human health and the environment.

To achieve these goals, RCRA established three distinct yet interrelated programs. The hazardous waste program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until it is ultimately disposed – in effect, from "cradle to grave". The solid waste program, under RCRA Subtitle D, addresses the disposal of nonhazardous industrial and municipal solid wastes. Finally, the underground storage tank program, under RCRA Subtitle I, regulates underground tanks storing hazardous substances and petroleum products. This discussion focuses mainly upon RCRA Subtitle C.

The regulations that EPA promulgated to implement RCRA Subtitle C are structured to first identify the criteria to determine which solid wastes are hazardous, and then establish various requirements for the three categories of waste handlers: 1) generators, 2) transporters, and 3) treatment, storage, and disposal (TSD) facilities. Additionally, the regulations set technical standards for the design and safe operations of TSD facilities and serve as a basis for developing and issuing the permits required by the Act for each facility.

RCRA, like most environmental legislation, encourages states to develop their own hazardous waste programs as an alternate to direct implementation of the federal program. To this end, the EPA has delegated its authority to IDEQ for all aspects of RCRA, with the exception of a few specific portions associated with the 1984 Hazardous and Solid Waste Amendments to RCRA.

During 2013, NRF continued to operate as a hazardous waste generator. As such, NRF must follow specific requirements for the handling/accumulation of hazardous waste under applicable Idaho State regulations. NRF did not have any compliance issues associated with RCRA regulated activities.

Federal Facility Compliance Act (FFCA)

The Federal Facility Compliance Act (FFCA) was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act (SWDA). The FFCA applied certain RCRA requirements and sanctions to federal facilities. In short, the FFCA waives sovereign immunity for federal facilities from all civil and administrative penalties and fines; this includes waivers for both coercive and punitive sanctions for violations of the SWDA. Relative to mixed waste, waste that contains both hazardous and radioactive material, the FFCA gave DOE sites until October 1995 to develop Site Treatment Plans (STPs) with schedules for mixed waste treatment and to obtain approval from federal or state regulatory agencies. NRF is included in the INL STP, which is updated annually.

The STP identifies the planned treatment options, schedules for shipment to selected treatment facilities, and arrangements for pre-treatment storage and post-treatment residual management for each mixed waste stream. Projected schedules for the start of operation of selected treatment facilities are identified and a single schedule milestone for shipment to the treatment facility within 12 months of the start of facility operations is incorporated for each waste stream. Thus, onsite pre-treatment storage at the INL is planned until the selected treatment facilities are available. The STPs also include commitments to perform additional evaluations and work with IDEQ to determine the viability of alternative treatment options, in the event completion of a targeted treatment facility is delayed.

NRF generates some mixed waste as a result of site operations. This waste represents a very small percentage of the total amount of mixed waste generated from DOE facilities. The STPs balance the concern of expeditious completion of treatment, cost/efficiency, minimizing shipments, and minimizing risk/liability, while representing the best overall plan for achieving compliance with Land Disposal Restriction (LDR) requirements for NRF's mixed waste.

Land Disposal Restrictions (LDR)

Since the enactment of the RCRA in 1976, a nationwide movement has been underway to restrict the land disposal of hazardous wastes. The 1984 Hazardous and Solid Waste Amendments required the EPA to issue four major sets of regulations collectively referred to as the "Land Disposal Restrictions".

The main purpose of the LDR program is to discourage activities that involve placing untreated wastes in or on the land when a better treatment or immobilization alternative exists. LDRs do not allow storage of restricted hazardous wastes, except for the purpose of accumulating such quantities as are necessary to facilitate proper recovery, treatment, or disposal. The amendments require that, prior to land disposal, all wastes meet treatment standards based on the "best demonstrated available technology."

The same restrictions apply to mixed waste. However, because adequate mixed waste treatment capacity remains an issue, regulatory agreements have been executed to achieve compliance. (See the previous discussion related to the FFCA.)

Hazardous and Solid Waste Minimization Program and Sustainability

EPA uses the term waste minimization to mean the reduction, to the extent feasible, of the generation of solid and hazardous waste. Both the solid waste program, under RCRA Subtitle D, and the hazardous waste program, under RCRA Subtitle C, have adopted waste minimization elements. EPA encourages source reduction and recycling of both hazardous and nonhazardous waste streams regulated by RCRA Subtitles C and D. EPA's hierarchy for a solid waste management program includes source reduction, recycling, waste combustion, and land filling, respectively.

NRF has implemented a hazardous waste minimization program that entails comprehensive plans to prevent and/or minimize the generation of hazardous waste in all NRF operations. These plans are designed to meet the hazardous waste reduction requirements of RCRA. The plans focus mainly on process efficiency improvements, source reduction, inventory control, preventive maintenance, improved housekeeping, recycling, and increasing employee awareness of and participation in pollution prevention.

NRF also has an Affirmative Procurement Plan that fosters the reuse of recycled commodities. When RCRA was enacted in 1976, Congress stated that objectives of the statute included the conservation of resources through recycling. Recognizing that recycling works best if there are markets for the materials collected, Congress directed the federal government to employ its purchasing power to help create and sustain markets by buying products manufactured with the collected (recycled) materials. Section 6002 of RCRA establishes the federal program that directs federal purchasing decisions for recycled products. NRF maintains an Affirmative Procurement

Plan that purchases EPA designated items in accordance with the DOE Agency Level Affirmative Procurement Guidelines. EPA designated items with recycled materials include but are not limited to: recycled paper and paper products, retread tires, concrete with fly ash, building insulation, recycled toner cartridges, reprocessed latex paint, recycled engine coolants and oils, etc. Each year, NRF supplies information regarding purchases of EPA designated items to the DOE, who formally submits a DOE Agency wide report to the Office of Management and Budget. In 2013, NRF purchased EPA designated items containing recycled material that met NRF availability, cost, and product performance requirements.

Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," was signed in January 2007; and Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," was signed in October 2009. These two Executive Orders identified objectives for reporting specific environmental and energy goals for all federal government agencies. Beginning in 2011, NRF, in conjunction with the Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, and Kesselring Site Operation, has identified specific environmental goals and their status of completion as part of the Environmental, Safety, and Health Management System.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly referred to as "Superfund". CERCLA's impetus was the emerging realization that inactive hazardous waste sites presented a great risk to public health and the environment and that existing law did not address these abandoned disposal sites. CERCLA was designed to respond to situations involving the past disposal of hazardous substances. As such, it complements RCRA, which regulates on-going hazardous waste handling and disposal.

The National Priorities List (NPL) is an important facet of CERCLA's response procedures. First established in 1981 under section 105(a)(8)(B) of CERCLA, the NPL is part of the National Contingency Plan and must be updated annually to list sites warranting evaluation and/or cleanup under CERCLA.

Hazard ranking calculations performed according to federal guidelines for judging the significance of chemical and radioactive residues have been conducted in accordance with federal law. These calculations indicate that the NRF Site scored well below the cutoff for designation to the NPL (Superfund) of high priority sites requiring prompt action to protect public health and safety. While NRF did not qualify for listing on the NPL as an individual facility, it was included with other INL facilities on the NPL and in the corresponding Federal Facility Agreement and Consent Order (FFA/CO) and Action Plan signed in 1991.

Under the FFA/CO, 87 sites were identified at NRF for investigation to determine potential risks to human health and the environment. Thirteen of the 87 sites were already evaluated prior to the FFA/CO under the Consent Order and Compliance Agreement which preceded and was replaced by the CERCLA FFA/CO. The remaining 74 sites were assessed as CERCLA-type investigations. The CERCLA investigations included Track 1, Track 2, and Remedial Investigation/Feasibility Study (RI/FS) type investigations. A Track 1 investigation involved sites that were believed to have

a low probability of risk and sufficient information available to evaluate the sites and recommend a course of action. A Track 2 investigation was conducted at sites that did not have sufficient data available to make a decision concerning the level of risk; for these sites, additional data collection was necessary. A RI/FS is the most extensive CERCLA investigation. It is intended to characterize the nature and extent of contamination, to assess risks to human health and the environment from potential exposure to contaminants, and to evaluate potential cleanup actions. In addition to the investigations performed for each site through a Track 1, Track 2, or RI/FS process, a comprehensive RI/FS was performed to assess the potential cumulative, or additive, effects to human health and the environment from all sites at NRF.

The investigation of the 87 sites resulted in 63 sites that required no action and were released for unrestricted use, twelve sites that only required institutional controls to prevent access to the sites because a source or potential source was present (referred to as No Further Action sites), and twelve sites that required remedial action. The remedial actions were completed at the twelve sites under two Records of Decision signed in 1994 and 1998 by Naval Reactors, the State of Idaho, and the EPA.

In 2008, one additional site was identified and remediated as a CERCLA non-time critical removal action and one site was reclassified from a No Further Action site to a site requiring no action. In addition, a removal action was performed at a No Further Action site in 2012 per a minor change to the 1998 Record of Decision (the site remains a No Further Action site). Also in 2012, another minor change to the 1998 Record of Decision released four No Further Action sites for unrestricted use (removed institutional controls) since it was determined that the source or potential source present represented an acceptable risk. Seven No Further Action sites remain under institutional controls.

The CERCLA monitoring data collected at NRF continue to support the conclusion that NRF operations have not had a significant impact on the environment or adverse effect on the surrounding communities. NRF has a well-defined program in place to protect the environment, to comply with the state and federal environmental requirements and interagency agreements, and to address remediation of the isolated residues found in the environment from previous activities.

Pollution Prevention

Pollution prevention programs meet the needs of the present day while laying the groundwork for a cleaner future. The President of the U.S. signed several Executive Orders that require federal agencies to set prevention-related goals for acquisitions, emission reductions, and solid waste prevention and recycling. While this is in keeping with the Pollution Prevention Act of 1990, this set of Executive Orders also brought federal agencies under the direction of the environmental "Right-to-Know" provisions.

NRF performs various functions to ensure the integration of pollution prevention strategies into the core of all business areas at the site. Listed below are the main focus areas, which are established at NRF to facilitate pollution prevention:

- Effectively institutionalize the pollution prevention ethic through training and awareness in all mission areas;
- Incorporate pollution prevention policy into the acquisition process;

- Complete Emergency Planning and Community Right-to-Know reporting;
- Address other environmental quality and pollution prevention focus areas; and
- Apply innovative pollution prevention technologies.

NRF ensures pollution prevention strategies are met by reviewing all chemical purchases and major construction projects to incorporate source reduction strategies for environmentally hazardous substances. Products containing recovered materials are also evaluated during the procurement process to ensure that post-consumer recycled products are procured whenever economically feasible. NRF also maintains and operates an extensive recycling program that entails recycling of batteries, light bulbs, heavy metal, clothing/laundry, oil, cardboard, telephone books, toner cartridges, scrap metal, cooking oil, aluminum cans, wood, and computers.

Toxic Substances Control Act (TSCA)

The U.S. Congress enacted the Toxic Substances Control Act (TSCA) in 1976. TSCA authorizes EPA to secure information on all new and existing chemical substances and to control those substances determined to cause an unreasonable risk to public health or the environment. Unlike many other environmental laws, which generally govern discharge of substances, TSCA requires a review of the health and environmental effects prior to the manufacture of new chemical substances for commercial use.

Polychlorinated biphenyls (PCBs) are regulated as a toxic substance under TSCA (40 CFR Part 761) and can range in physical form from oily liquids to white crystalline solids. PCBs were commonly used prior to 1979 mainly as a dielectric fluid in electrical equipment such as transformers and capacitors. In addition, PCBs were added to certain paint coatings prior to 1980 to increase resistance to heat, chemicals, or fire.

NRF has removed all known PCB electrical transformers. Remaining PCBs are primarily painted items and some lighting fixtures with PCB-containing ballasts. NRF employs strict controls for the proper handling and disposal of PCB items.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The Insecticide Act of 1910 established the first federal control over the use of pesticides. In 1947, Congress enacted the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which has since been amended several times. By 1972, this law was virtually rewritten. This statute gives EPA the authority over the field-scale use of pesticides and requires the registration of all pesticides used in the U.S. EPA restricts the application of pesticides through state-administered certification programs. Only state certified commercial applicators or personnel under their supervision are allowed to apply restricted-use pesticides at NRF. The applicator is responsible for providing the appropriate pesticides, application equipment, and for the proper use and disposal of all pesticide waste, including empty containers. Authorized site personnel are only allowed to apply herbicides such as lawn care products and fertilizer at NRF. There is no pesticide disposal at NRF. The washing of restricted pesticide/herbicide application equipment on site is also prohibited.

All FIFRA required reports are completed by the certified applicator for all pesticides and rodenticides. All chemicals applied by a subcontractor, licensed commercial application, business, or under their guidance, are reported directly by the subcontractor.

National Environmental Policy Act (NEPA)

All significant construction, renovation, and demolition activities are reviewed for their potential impact on the environment under the National Environmental Policy Act (NEPA) requirements, as provided by the DOE. Other physical construction projects or capital equipment that have the potential for creating new emissions to the environment are also evaluated under NEPA.

Emergency Planning and Community Right-To-Know Act (EPCRA)

All federal agencies must comply with the planning and reporting provisions of the Emergency Planning and Community Right-to-Know Act (EPCRA). Sections 302 to 304 of EPCRA (Subtitle A) require the creation of emergency response and emergency planning authorities. These authorities are known as the State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC). This subtitle also requires facilities that have extremely hazardous substances (EHSs) above their respective Threshold Planning Quantity (TPQ) to give notice that these substances are present at that facility and to report releases of those substances and other listed hazardous substances in excess of their respective reportable quantity.

Sections 311 to 313 (Subtitle B) establish the reporting requirements under EPCRA. NRF's status for EPCRA reporting is shown below in Table 3. Section 311 requires the submission of Material Safety Data Sheets/Safety Data Sheets (MSDSs/SDSs) or a list of chemicals (grouped by hazard category) for which an MSDS/SDS is required. Reporting is required for hazardous chemicals stored onsite in quantities greater than 10,000 pounds and for extremely hazardous substances present in quantities greater than 500 pounds or the TPQ (which ever is less). Under Section 312, NRF coordinates with the INL to complete an annual Tier II Inventory Report for all hazardous chemicals present in excess of the specified quantities during the previous calendar year. The information is submitted to the SERC, LEPCs, and local fire departments for emergency planning purposes.

Section 313 of EPCRA establishes the Toxic Release Inventory (TRI), which requires certain facilities with North American Industry Classification System (NAICS) codes to report annually to the EPA on whether they manufacture, process, or otherwise use any of the listed toxic chemicals above the designated activity thresholds. The FFCA requires all federal facilities regardless of NAICS code to complete TRI reports if the listed activity threshold quantities are exceeded. During 2001, the EPA lowered the Section 313 reporting thresholds for chemicals classified as persistent, bioaccumulative, and toxic. NRF did not meet any Section 313 reporting thresholds. However, the INL had toxic chemicals above reporting thresholds in 2013, therefore requiring NRF to report its chemical inventory via INL to comply with Section 313 of EPCRA.

Table 3 – Status of NRF Site EPCRA Reporting

EPCRA Section	Description of Reporting	Status
EPCRA Sec. 302-303	Planning Notification	Notification completed for the calendar year
EPCRA Sec. 304	EHS Release Notification	Notification completed for the calendar year
EPCRA Sec. 311-312	MSDS/SDS/Chemical Inventory	Notification completed for the calendar year
EPCRA Sec. 313	TRI Reporting	Notification completed for the calendar year*

* Notification is required due to INL inventory, which NRF is a part of. Individually, NRF did not meet any EPCRA Section 313 reporting thresholds.

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4 ENVIRONMENTAL MONITORING

4.1 PROGRAM OVERVIEW

The NRF environmental monitoring program, which includes radiological and nonradiological monitoring, is conducted in accordance with accepted monitoring procedures and management practices to ensure compliance with applicable federal, state and local standards. A complete synopsis of sampling and analyses performed in support of the NRF environmental monitoring program can be found in Tables 4 and 5. Data from this monitoring program confirm that operations at NRF have not had adverse effects on the quality of the environment or the health and safety of the general public. These results are summarized below and discussed in detail in the following sub sections.

Samples of liquid effluent and sediment are collected at the Industrial Waste Ditch (IWD). These samples are analyzed for both chemical constituents and radioactivity. At the sanitary sewage lagoon, samples of liquid effluent are collected and analyzed for radioactivity.

The drinking water monitoring program involves the collection of water samples at the wellheads (radiological) or a point prior to entering the distribution system (nonradiological) to ensure a high quality drinking water supply at NRF. Nonradiological samples are drawn from a sampling port immediately downstream of the water softening treatment system. In addition, drinking water samples collected throughout the NRF distribution system are analyzed for the presence of coliform and E. Coli bacteria in accordance with Reference 4.

The groundwater monitoring program is designed to ascertain whether NRF operations have had an impact on groundwater quality. Samples are collected on an established schedule from 11 groundwater monitoring wells surrounding NRF. These samples are analyzed for chemical constituents and radioactivity.

Airborne air quality effluents are either monitored or calculated to ensure NRF's air emissions meet federal and state standards. Trained and certified visual emissions observers monitor emissions from fuel-burning equipment and particulate matter from area sources at NRF. In addition, NRF monitors and/or calculates the airborne radioactivity emissions from radiological areas. These calculations are performed in accordance with established standards and guidelines.

Continuous direct measurement of radiation levels at the NRF site is accomplished by dosimeters located along the security fence. NRF conducts this monitoring and INL independently conducts additional monitoring. Gonzales-Stoller Surveillance measures radiation levels at offsite background locations.

NRF performs soil and vegetation monitoring at the NRF site to ensure that NRF operations do not adversely impact the surrounding environment. Data collected from soil sampling is used to calculate fugitive air emissions.

Because it is located on the INL, NRF is party to a FFA/CO for environmental remediation under CERCLA. Groundwater, surface soils, and subsurface soils were sampled and analyzed in 1996 as

part of the NRF Comprehensive RI/FS. The results of this investigation were documented in the NRF Comprehensive RI/FS Report dated October 21, 1997.

In 1996, NRF completed remedial actions on three inactive landfill areas. Initial groundwater and soil gas samples were collected and analyzed after the construction phase of the remedial action. The results of the groundwater sampling efforts, which supported the inactive landfill Remedial Action, appeared in the Final Remedial Action Report. This report was issued to the State of Idaho and the EPA on February 20, 1997.

These inactive landfill areas have now entered into the Operation and Maintenance (O&M) phase as described in the Remedial Action Report. In support of the O&M phase, groundwater and soil gas samples will continue to be collected and analyzed on a routine basis.

On September 30, 1998, EPA, State of Idaho, and DOE, Naval Reactors Idaho Branch Office signed a Record of Decision (ROD), which delineated performance of remedial actions at NRF. These actions included pipe and soil removal, consolidation, and containment.

In 2004, NRF completed remedial actions associated with this ROD including the construction of three engineered covers. These covers have entered into the O&M phase, which includes groundwater and soil/vegetation sampling.

A complete summary of the data collected during routine environmental groundwater and soil gas monitoring is presented in this Environmental Monitoring Report. The results of this monitoring support the conclusion that operation of NRF has had no adverse effect on the quality of the environment or the health and safety of the general public and that the cleanup activities at NRF have resulted in actions that are protective of human health and the environment.

Table 4 – Radiological Environmental Monitoring Program

Sample Type/Location	Data/Sample Collection Method [(1)]	Analysis Frequency	Routine Analysis
LIQUID EFFLUENT			
INDUSTRIAL WASTE DITCH			
Water (At Outfall)	Grab	Quarterly	Quantitative isotopic gamma
Water (At Outfall)	Grab	Quarterly	Strontium-90 and tritium (Composite)
Sediment (At Outfall)	Grab	Quarterly	Quantitative isotopic gamma
Sediment (Along length)	Grab (6 each)	Annually	Quantitative isotopic gamma
Vegetation (Along length)	Grab (10 each)	Annually	Quantitative isotopic gamma
SEWAGE LAGOON			
Water	Grab	Quarterly	Quantitative isotopic gamma
Water	Grab	Quarterly	Strontium-90 and tritium (H-3) (Composite)
DRINKING WATER			
Onsite Wells	Grab	Quarterly	Gross alpha, gross beta, and tritium (H-3)
Onsite Wells	Grab	Annually	Strontium-90 and quantitative isotopic gamma (Composite)
GROUNDWATER			
Regional Up-gradient Well, Effluent Monitoring Well, and Site Down-gradient Wells	Grab	Semiannually	Tritium (H-3), strontium-90, and cesium-137
Regional Down-gradient Wells	Grab	Every other year (2012, 2014, etc.)	Tritium (H-3), strontium-90, and cesium-137
AIR EFFLUENT			
Fixed Filter Air Samplers	Continuous	Weekly & Biweekly	Gross alpha and gross beta Quantitative isotopic gamma
Tritium Samplers	Continuous	Monthly	Tritium (H-3) in water vapor
Charcoal Cartridges	Continuous	Weekly	Iodine-131
Selected Emission Points	Calculated based upon production	Monthly	Carbon-14 Krypton-85 Iodine-129 Tritium (H-3) gas
Fugitive Air Emissions from Windblown Soil	Calculated based upon soil characterization	Annually	Cesium-137 and cobalt-60

Table 4 – Radiological Environmental Monitoring Program – Cont.

Sample Type/Location	Data/Sample Collection Method[1]	Analysis Frequency	Routine Analysis
SOIL AND VEGETATION			
NRF Perimeter	Random Grab (40 each)	Annually	Quantitative isotopic gamma
Engineered Cover Area S1W Leaching Beds and Old Sewage Basin	Random Grab and Radiation Survey (40 each) [2]	Annually	Quantitative isotopic gamma and radiation level
Engineered Cover Area A1W Leaching Bed	Random Grab and Radiation Survey (40 each) [2]	Annually	Quantitative isotopic gamma and radiation level
Sewage Lagoon (Southwest inactive cell)	Random Grab (40 each)	Annually	Quantitative isotopic gamma
GENERAL SITE RADIATION			
NRF Perimeter Fence	Survey	Annually	Radiation level
Background Locations	Survey	Annually	Radiation level
Environmental Dosimeters (Perimeter, Background)	Continuous	Quarterly	Gamma exposure

(1) Single samples collected at each location unless specified in parentheses (total excludes the collection of quality assurance samples.

(2) Collection method includes a combination of sample locations and survey locations.

Table 5 – Nonradiological Environmental Monitoring Program

Sample Type/Location	Data/Sample Collection Method	Analysis Frequency	Routine Analysis
LIQUID EFFLUENT			
INDUSTRIAL WASTE DITCH			
Water (At Outfall)	Composite	Monthly	Aluminum, antimony, barium, chloride, iron, manganese, nitrate as nitrogen, nitrite as nitrogen, nitrogen (total Kjeldahl), oil and grease, pH, potassium, sodium, specific conductance, sulfate, thallium, total dissolved solids, total suspended solids
Sediment (At Outfall)	Grab	Annually	Aluminum, antimony, barium, chloride, iron, manganese, nitrate as nitrogen, nitrite as nitrogen, nitrogen (total Kjeldahl), oil and grease, pH, potassium, sodium, specific conductance, sulfate, thallium

Table 5 – Nonradiological Environmental Monitoring Program – Cont.

Sample Type/Location	Data/Sample Collection Method	Analysis Frequency	Routine Analysis
DRINKING WATER			
Drinking Water/ Distribution System at selected locations	Grab	Monthly	Coliform bacteria (total)
Drinking Water/ Distribution System at selected locations	Grab	Three times from 2011 to 2019*	Copper and lead
Drinking Water/ Manifold	Grab	Once during 2011 to 2016*	Regulated volatile organic compounds (VOCs).
Drinking Water/ Manifold	Grab	Annually	Nitrate as nitrogen
Drinking Water/ Manifold	Grab	Once during 2011 to 2019*	Nitrite as nitrogen
Drinking Water/ Manifold	Grab	Once during 2011 to 2019*	Antimony, barium, beryllium, cadmium, chromium, copper, fluoride, mercury, nickel, selenium, thallium, and regulated semi-volatile organic compounds (SOCs) (Atrizine, Phthalates, Adipates, EDB (Ethylene dibromide), DBCP (Dibromochloropropane))
Drinking Water/ Manifold	Grab	Once during 2011 to 2019*	Regulated SOCs (Pentachlorophenol, 2-4-DB, 2-4-5-TP (Silvex), 2-4-D, Dalapon, Dinoseb, Picloram)
GROUNDWATER			
Regional Up-gradient Well, Effluent Monitoring Well, and Site Down-gradient Wells	Grab	Semiannually	Aluminum, antimony, arsenic, barium beryllium, cadmium, calcium, chloride, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, nitrate-nitrite as nitrogen, nitrite as nitrogen, pH, potassium, selenium, silver, sodium, specific conductance, sulfate, total dissolved solids, thallium, zinc
Regional Down-gradient Wells	Grab	Every other year (2012, 2014, etc.)	
Regional Up-gradient Well, Effluent Monitoring Well, and Site Down-gradient Wells	Grab	Annually	Selected VOCs and SOCs
Regional Down-gradient Wells	Grab	Every other year (2012, 2014, etc.)	

* Waivers granted by the State of Idaho Department of Environmental Quality for 2011 through 2019.

Table 5 – Nonradiological Environmental Monitoring Program – Cont.

Sample Type/Location	Data/Sample Collection Method	Analysis Frequency	Routine Analysis
SOIL GAS MONITORING			
Soil gas monitoring probes for Site 8-05-1	Grab	Semiannually	Selected VOCs
Soil gas monitoring probes for Sites 8-05-51 and 8-06-53	Grab	Annually	Selected VOCs
Selected surface soil gas emission points for Sites 8-05-1, 8-05-51, and 8-06-53	Survey	Annually	Total VOCs
AIR MONITORING			
Selected emission points	Calculated	Annually	Criteria and Hazardous air pollutants (HAPs) including: Carbon dioxide (CO_2), selected Greenhouse Gases (GHG), nitrogen oxides (NO_x), particulate matter, sulfur dioxide (SO_2), and VOCs
Boiler emissions	Calculated	Monthly	NO_x
Point Source Visible Emissions Survey	Visual Observation	Quarterly	Observed, not observed, or Method 9 in accordance with the Tier I Operating Permit
Fugitive Dust	Visual Observation	Quarterly	Surveillance of new and existing sources of fugitive dust in accordance with the Tier I Operating Permit

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4.2 LIQUID EFFLUENT MONITORING

The purpose of the liquid effluent monitoring program is to confirm that no chemically hazardous or radioactive wastes have been discharged to the environment.

SOURCES AND TREATMENT

NONRADIOLOGICAL

Non-radioactive water disposal at NRF is segregated into two separate systems. Water from NRF operations and storm water runoff is discharged to the Industrial Waste Ditch (IWD). Sanitary wastewater from NRF is discharged to an evaporative sewage lagoon.

Industrial Waste Ditch

The IWD system at NRF consists of two discrete parts. The interior portion of the IWD system is comprised of a network of buried pipes, culverts, and open channels within the NRF security fence. This network empties storm water and process water into a covered exterior culvert, which flows through an environmental monitoring station vault, and ultimately outfalls to an uncovered exterior channel at the northwest corner of NRF.

The exterior portion of the IWD system begins at this outfall and progresses 3.2 miles northeast from NRF into the desert along a former creek bed. An earthen berm across the creek bed prevents water from traveling further down this concourse. Water discharged through the IWD system is dissipated through a combination of percolation and evapo-transpiration along the course of the exterior IWD. Normally, no surface water is visible beyond 300 yards from the outfall.

Approximately 5.4 million gallons of water were released to the IWD during 2013. Sources of water to the IWD primarily include storm water, snowmelt runoff, and ion exchange regeneration solutions.

Sewage Lagoon

In February 2012, NRF began operation of a new 21-acre, dual cell, lined sanitary lagoon. This lagoon system was installed to replace the existing clay lined lagoon that had been in operation since the 1960s. This new lagoon system was constructed to meet the new design standards for state seepage testing requirements for wastewater lagoons. A valve box located in the southern berm of the lagoon allows wastewater to be directed to either one or both of the cells depending upon the volume of wastewater being generated. An equalization line is located at the opposite end of the cells to stabilize the water level between the cells if needed.

Approximately 7.5 million gallons of sanitary sewage were discharged to the sewage lagoon in 2013. The sewage lagoons work primarily through aerobic digestion with anaerobic digestion occurring in the sludge layer. Any remaining liquid is dissipated by evaporation. An additional 20 million gallons of clean water were added to the lagoon system in the summer of 2013 in order to maintain proper water levels required for digestion during the hot, dry summer months and via discharges from a ground source heat exchanger system used to maintain building temperatures.

RADIOLOGICAL

A water reuse system is operated at NRF to collect, process, and reuse radioactive liquids rather than discharge them to the environment.

MONITORING, ANALYSES, AND RESULTS

Liquid effluents discharged to the IWD were analyzed for chemical constituents and radioactivity. Liquid effluents discharged to the sewage lagoon were only analyzed for radioactivity.

NONRADIOLOGICAL

In 2007, the IWD became permitted as a "reuse treatment system" by the IDEQ. Until this permit was issued, no monitoring was required for this facility by regulatory agencies. However, NRF has always monitored the IWD as a best management practice. This permit requires certain analytes to be monitored and also stipulates the frequency they are to be monitored. Specific details pertaining to the monitoring and operation of this facility are discussed in an annual reuse report required by the permit.

Analytes are reported based on requirements of the reuse permit. Composite samples of the liquid effluents discharged to the IWD were collected monthly at the outfall of the interior drainage system. A summary of the required liquid effluent monitoring results from the IWD is presented in Table 6. Results of monitoring showed no appreciable concentrations of heavy metals and a near neutral pH in the IWD liquid effluent.

Various concentrations of calcium, chloride, magnesium, sodium and other ions are also present in the liquid effluent from NRF because of water softening and demineralization activities. Although the amount of ionic salts discharged to the IWD has decreased, detected levels of several salts have increased relative to 1997 concentrations due to decreasing water discharges to the IWD (e.g., changing from water cooled to air cooled air compressors). None of these constituents were harmful to the environment or violated any permit limits at the levels discharged from NRF.

In addition, sediment samples were collected at the outfall of the IWD to confirm that NRF did not inadvertently discharge hazardous substances. These samples were analyzed for the same constituents as the liquid effluent samples except for total dissolved and total suspended solids. Results of the analysis of the sediment samples were typical of the values reported in the IWD RI/FS performed under the INL FFA/CO.

RADIOLOGICAL

Water samples collected from the IWD and sewage lagoon were analyzed for quantitative gamma, tritium, and strontium-90 radioactivity. The analytical results confirmed that no programmatic radioactivity above natural background levels was present in liquid effluent streams discharged from NRF.

Sediment samples collected at the outfall of the IWD were analyzed using gamma spectrometry to identify gamma-emitting radionuclides. The analytical results further confirmed that no programmatic radioactivity above natural background levels was discharged in liquid effluent streams from NRF. In addition, vegetation and sediment samples collected along the wetted portion of the IWD did not reveal any programmatic radioactivity above background levels.

LIQUID EFFLUENT MONITORING CONCLUSIONS

NONRADIOLOGICAL

The liquid effluent monitoring confirms that nonradiological liquid effluents from NRF were controlled in accordance with applicable federal and state laws. The levels of nonhazardous ionic salts of calcium, chloride, magnesium, and sodium concentrations that NRF discharged via the IWD have had no adverse effect on the quality of the environment.

RADIOLOGICAL

No radioactive liquid effluents were discharged from NRF. Monitoring shows that the procedures and equipment used to process radioactive liquids have been effective in eliminating intentional discharges to the environment.

Table 6 – Summary of Liquid Effluent Water Quality Analyses

PARAMETER	UNITS	INDUSTRIAL WASTE DITCH		
		MIN	MAX	MEAN(2)
Aluminum	mg/L	<0.015	<0.375	<0.126
Antimony	mg/L	<0.001	<0.020	<<0.003
Barium	mg/L	1.14	2.56	1.76
Chloride	mg/L	4,970	15,600	10,129
Iron	mg/L	1.24	3.24	2.13
Manganese	mg/L	0.0929	0.327	0.170
Nitrate As Nitrogen(1)	mg/L	<0.165	3.20	<0.99
Nitrite As Nitrogen(1)	mg/L	<0.760	<7.6	<<5.3
Nitrogen (Total Kjeldahl) (1)	mg/L	0.571	1.88	1.08
Oil And Grease	mg/L	<1.12	2.82	<1.85
pH	pH	7.67	8.72	7.99
Potassium	mg/L	19.7	34.2	27.5
Sodium	mg/L	2,580	9,030	6,553
Specific Conductance	µmho/cm	17,280	41,000	30,678
Sulfate	mg/L	32.5	145	85
Thallium	mg/L	<0.00045	<0.009	<<0.001
Total Dissolved Solids (TDS)	mg/L	9,950	25,000	18,329
Total Suspended Solids (TSS) (1)	mg/L	3.05	15.1	6.5

(1) This analyte is monitored as required by the Industrial Reuse Permit issued by the Idaho Department of Environmental Quality to NRF, on July 26, 2007. The nitrogen limit shall not exceed 20 mg/L and the TSS limit shall not exceed 100 mg/L.

(2) Mean values preceded by < contained at least one "less than minimum detection level" (MDL) value in the data set for that parameter. Mean values preceded by << contained all "less than MDL" values in the data set for that parameter and were the average of the MDLs.

4.3 DRINKING WATER MONITORING

NRF conducts a comprehensive drinking water monitoring program to ensure a high quality drinking water supply.

SOURCES

Designated as onsite wells, NRF 1, 2, 3, 4 and 14 are within the security fence and provide all water utilized for production and domestic use. In January of 1994, NRF wells 1 and 4 were permanently removed from the NRF drinking water system. These two wells currently provide water for the NRF fire main system and lawn watering.

NRF wells 2 and 3 provided all domestic (drinking) water for NRF from 1994 to 2006. In 2006, well 2 was removed from service leaving well 3 as the only well providing drinking water to the facility. NRF began the process of developing a new well (well 14) to replace well 2 for drinking water. Well 14 became fully operational in March of 2009. Since 2009, wells 3 and 14 have provided all domestic water for NRF.

MONITORING, ANALYSES, AND RESULTS

NRF's drinking water monitoring program is conducted in compliance with requirements established by the State of Idaho and the Safe Drinking Water Act.

NONRADIOLOGICAL

Drinking water samples were collected and analyzed for the presence of coliform bacteria and E. Coli. Results were reported monthly to IDEQ per the requirements of applicable federal and state regulations. Sampling locations were randomly selected at points throughout the distribution system. These samples were analyzed by a state-certified laboratory. Results confirmed the absence of coliform and E. Coli bacteria in the water supply.

Other drinking water samples were collected from the required locations for specific analytes. These locations include the source water prior to entering the distribution system (a sampling port immediately downstream of the water softening treatment system at the drinking water system manifold) and water drawn from sampling taps throughout the distribution system.

RADIOLOGICAL

Samples were drawn from all four currently operating wells (1, 3, 4 and 14) and analyzed for radiological drinking water parameters. These samples were submitted for analyses to a subcontracted laboratory. Analytical results reported for these samples were consistent with the standards identified in the Idaho Regulations for Public Drinking Water Systems.

DRINKING WATER MONITORING CONCLUSIONS

NONRADIOLOGICAL

Monitoring of the NRF drinking water system for bacterial contaminants demonstrated compliance with public drinking water regulations. Drinking water monitoring for required parameters verified that no contaminants were present in NRF drinking water above levels established by drinking water standards.

RADIOLOGICAL

The radioactivity levels in the drinking water were significantly below levels established by drinking water standards.

4.4 GROUNDWATER MONITORING

NRF conducts a comprehensive groundwater monitoring program to verify that NRF operations have not adversely affected the quality of the groundwater.

SOURCES AND TREATMENT

The top of the Snake River Plain Aquifer is approximately 385 feet below the ground surface at NRF. Previous studies at the INL have determined that the groundwater moves along a horizontal flow path northeast to the southwest with a velocity ranging from 2 to 20 feet per day. (Reference 3).

Figure 3 plots the location of all wells used for groundwater monitoring at NRF (NRF-6, NRF-8, NRF-9, NRF-10, NRF-11, NRF-12, NRF-16, USGS-97, USGS-98, USGS-99, and USGS-102). These wells are located within a 3-mile radius of the developed portion of the NRF site. These wells were sampled by the United States Geological Survey (USGS). For analysis purposes, these wells are placed into four groups consistent with the well groupings of the hydrogeologic study that was performed in 1996 as part of the NRF Comprehensive Remedial Investigation associated with CERCLA.

NRF-16 is located approximately 1.4 miles north of NRF and is used to monitor water which is hydrologically up-gradient to NRF and which is representative of regional background quality. It is the only “Regional Up-gradient” well currently used by NRF. NRF-6 is termed the “Effluent Monitoring” well and is located 0.1 miles north of NRF, next to the IWD. These wells were each sampled twice during 2013.

One well (USGS-102) constructed in 1989, and five wells (NRF-8, NRF-9, NRF-10, NRF-11, and NRF-12) constructed in 1996, are termed “Site Down-gradient” wells. These wells are located just south of NRF along an arc extending from USGS-102 on the west to NRF-12 on the east. These wells are used to assess potential migration of constituents from the IWD, sewage lagoon, and the NRF site. Most wells in this group have produced consistently low results. However, the results from NRF-10 have typically contained slightly elevated metal concentrations believed to be associated with suspended sediments in the water samples. These wells were also sampled twice during 2013.

Three wells (USGS-97, USGS-98, and USGS-99) are located between 0.5 and 3 miles south of NRF and are termed “Regional Down-gradient" wells. These wells are used to monitor water which is hydrologically down-gradient of the NRF facility or which is representative of regional background quality. In accordance with the CERCLA O&M Plan, groundwater samples from the Regional Down-gradient wells were not required to be sampled during 2013. These wells are scheduled to be sampled in the spring of 2014.

MONITORING, ANALYSES, AND RESULTS

NRF manages a groundwater monitoring program, which includes the collection and analysis of samples from monitoring wells surrounding NRF. In 2013, groundwater samples were collected by USGS personnel and analyzed by laboratories contracted by NRF. During this reporting period,

NRF completed all required sampling from NRF-6, NRF-8 through NRF-12, NRF-16, and USGS-102.

All sample results are reviewed by an independent data validator. Results are evaluated against standardized criteria for laboratory quality control. No significant validation issues were noted. The analytical results are described below.

NONRADIOLOGICAL

Groundwater monitoring was conducted through the collection and analysis of samples from Regional Up-gradient, Effluent Monitoring, and Site Down-gradient wells. Most of the target analytes were derived from those used for the drinking water monitoring program. The results of analyses for inorganic chemical constituents and other selected parameters are summarized in Table 7 and discussed below.

The mean ionic concentrations of calcium, chloride, magnesium, potassium, sodium, and sulfate measured at the Effluent Monitoring well, NRF-6, were higher than results from any other well grouping. The results for two field parameters, specific conductance and Total Dissolved Solids (TDS) were also high. These elevated constituents and parameters can be attributed to the discharge of salts from the site water softener and demineralization systems (see Liquid Effluent Monitoring section). The mean annual concentration of chloride and TDS exceeded their Secondary Maximum Contaminant Level (SMCL) of 250 milligrams per liter (mg/L) and 500 mg/L respectively. The mean annual concentration of chloride has decreased steadily from 550 mg/L in 2009 to 465 mg/L during the current reporting period. The concentration of sulfate was approximately one-third its SMCL. The remaining constituents discussed above do not have associated SMCLs. These results are typical for well NRF-6. Salt constituents at concentrations found in the Effluent Monitoring well do not detrimentally affect public health and safety.

The mean concentration of chromium in well NRF-6 (0.037 mg/L) is elevated compared to the other well groups. This concentration reflects historical releases to the IWD. However, it is approximately one-third the Maximum Contaminant Level (MCL) of 0.100 mg/L, and it is lower than the previous three years.

All wells were sampled for selected volatile and semi-volatile organic compounds once during 2013. Bromacil was detected in NRF-6 as a tentatively identified compound at a concentration of 0.66 micrograms per liter. Bromacil is a herbicide that is used to control weed growth around the NRF site. Bromacil is not considered harmful to human health or the environment at this concentration. All other detected organic compounds, whether a target compound or a tentatively identified compound, are likely related to sample equipment or laboratory cross-contamination (e.g., bis-(2-ethylhexyl) phthalate and di-n-butylphthalate, which are common components of plastics).

RADIOLOGICAL

All samples were analyzed for tritium, quantitative isotopic gamma, and strontium-90. All results were below the Minimum Detectable Concentration (MDC) for all strontium-90 and programmatic gamma emitter samples. A review of these data indicates that the average activity level for tritium in the Effluent Monitoring well and Site Down-gradient well group are at or below the background

level of 27 pCi/g (picocuries per gram). Tritium concentrations in these wells continue to trend downward. The results for radioactivity in groundwater are shown in Table 8.

During 2010-2012, the USGS, in cooperation with the U.S. DOE, collected groundwater samples for I-129 from 62 wells in the eastern Snake River Plain Aquifer to track concentration trends and changes. In 2011, the USGS collected and analyzed samples from wells NRF-6, NRF-8, NRF-9, NRF-10 and NRF-11 for I-129 using an ultra-sensitive analytical method. Those results were reported by the USGS in 2013.

These wells were sampled for I-129 for the first time and had I-129 concentrations slightly greater than background concentrations found in the aquifer. All results were several orders of magnitude below the Maximum Contaminant Level for I-129 in drinking water (1 pCi/L) and do not pose a threat to human health or the environment.

GROUNDWATER MONITORING CONCLUSIONS

NONRADIOLOGICAL

The Effluent Monitoring well, NRF-6, used to monitor the migration of constituents from the IWD, showed elevated mean concentrations of calcium, chloride, magnesium, potassium, sodium, and sulfate ions. The mean annual concentration of chloride was above applicable secondary drinking water standards, but at its lowest concentration since 2009. These constituents, including chloride, are nonhazardous water softening and demineralization process ions. The TDS concentration in well NRF-6 also exceeded the SMCL. This exceedance was due primarily to the elevated levels of chloride (in its dissolved salt form) discussed above. The mean concentration for chromium in well NRF-6 was also elevated compared to the other well groups; however, a concentration at this level does not have a detrimental effect on the quality of the groundwater, human health, or the environment. Chromium concentrations at NRF are well below federal drinking water guidelines.

RADIOLOGICAL

Analysis of NRF groundwater samples showed that strontium-90 and programmatic gamma emitters were at or below the MDC. Measurements for tritium were two orders of magnitude below drinking water standards. These levels do not pose a threat to human health or the environment.

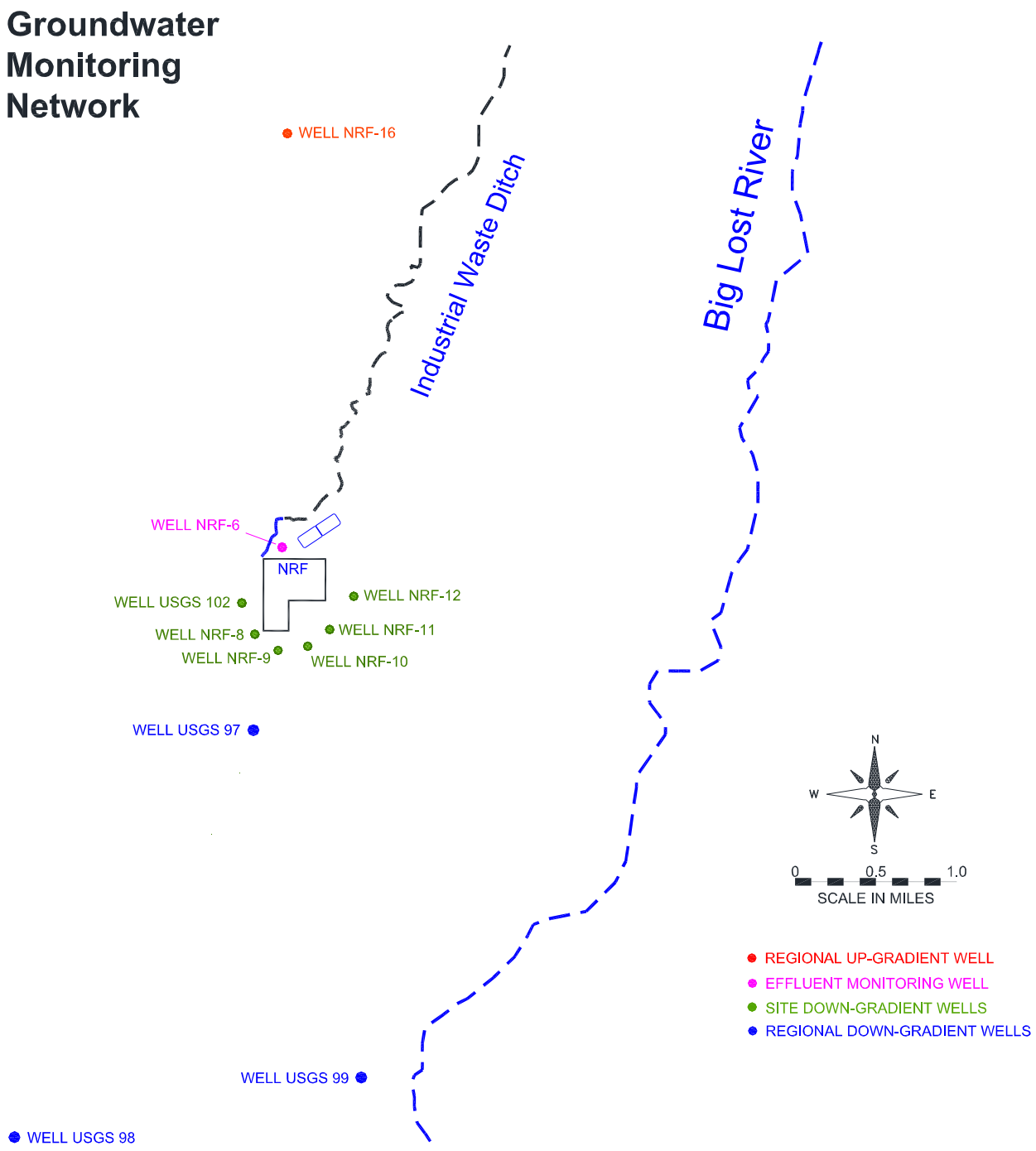

Figure 3 – Groundwater Monitoring Network

Table 7 – Summary of Groundwater Analyses – Inorganic and Other Selected Parameters

PARAMETER	UNITS	GUIDELINE (1)	REGIONAL UP-GRADIENT (Well NRF-16)		EFFLUENT MONITORING (Well NRF-6)		SITE DOWN-GRADIENT (Wells NRF-8, 9, 10, 11, 12, & USGS 102)		REGIONAL DOWN-GRADIENT (Wells USGS 97, 98, & 99)	
			RANGE	MEAN (2)	RANGE	MEAN (2)	RANGE	MEAN (2)	RANGE	MEAN
Aluminum	mg/L	0.2	<< 0.018	<< 0.018	<< 0.018	<< 0.018	< 0.018 to 0.160	< 0.036	No Samples in 2013	
Antimony	mg/L	0.006	<< 0.00040	<< 0.00040	<< 0.00040	<< 0.00040	< 0.00040 to 0.00100	< 0.00047	No Samples in 2013	
Arsenic	mg/L	0.010	0.00160 to 0.00190	0.00175	0.00250 to 0.00300	0.00275	0.00130 to 0.00180	0.00167	No Samples in 2013	
Barium	mg/L	2	0.075 to 0.082	0.079	0.120 to 0.140	0.130	0.110 to 0.150	0.138	No Samples in 2013	
Beryllium	mg/L	0.004	<< 0.00047	<< 0.00047	<< 0.00047	<< 0.00047	<< 0.00047	<< 0.00047	No Samples in 2013	
Cadmium	mg/L	0.005	<< 0.00045	<< 0.00045	<< 0.00045	<< 0.00045	<< 0.00045	<< 0.00045	No Samples in 2013	
Calcium	mg/L	(3)	42 to 43	43	130 to 150	140	62 to 74	68	No Samples in 2013	
Chloride	mg/L	250	14	14	420 to 510	465	30 to 49	40	No Samples in 2013	
Chromium	mg/L	0.1	0.0078 to 0.0092	0.0085	0.0350 to 0.0390	0.0370	0.0061 to 0.0200	0.0128	No Samples in 2013	
Copper	mg/L	1.0	<< 0.0014	<< 0.0014	< 0.0014 to 0.0016	< 0.0015	<< 0.00140	<< 0.0014	No Samples in 2013	
Iron	mg/L	0.3	< 0.022 to <(5) 0.028	<< 0.025	< 0.022 to <(5) 0.079	<< 0.051	< 0.022 to 0.510(6)	< 0.098	No Samples in 2013	

Table 7 – Summary of Groundwater Analyses – Inorganic and Other Selected Parameters, Cont.

PARAMETER	UNITS	GUIDELINE [1]	REGIONAL UP-GRADIENT (Well NRF-16)		EFFLUENT MONITORING (Well NRF-6)		SITE DOWN-GRADIENT (Wells NRF-8, 9, 10, 11, 12, & USGS-102)		REGIONAL DOWN-GRADIENT (Wells USGS-97, 98, & 99)	
			RANGE	MEAN [2]	RANGE	MEAN [2]	RANGE	MEAN [2]	RANGE	MEAN
Lead	mg/L	0.015 [4]	<< 0.0026	<< 0.0026	<< 0.0026	<< 0.0026	< 0.0026 to 0.0032	< 0.0027	No Samples in 2013	
Magnesium	mg/L	[3]	15 to 16	16	37 to 38	38	20 to 22	21	No Samples in 2013	
Manganese	mg/L	0.05	0.00045 to <[5] 0.00470	< 0.00258	< 0.00025 to <[5] 0.01300	<< 0.00663	< 0.00025 to <[5] 0.00940	< 0.00195	No Samples in 2013	
Mercury	mg/L	0.002	<< 0.000027	<< 0.000027	<< 0.000027	<< 0.000027	<< 0.000027	<< 0.000027	No Samples in 2013	
Nickel	mg/L	[3]	<< 0.0013	<< 0.0013	0.0015 to 0.0060	0.0038	< 0.0013 to 0.0042	< 0.0021	No Samples in 2013	
Nitrate-Nitrite Measured As Nitrogen	mg/L	10	0.69 to 0.71	0.70	1.90 to 2.10	2.00	2.10 to 2.80	2.33	No Samples in 2013	
Nitrite Measured As Nitrogen	mg/L	1	<< 0.049	<< 0.049	<< 0.049	<< 0.049	<< 0.049	<< 0.049	No Samples in 2013	
pH	pH	6.5 to 8.5	7.96 to 8.07	8.01	7.70 to 7.80	7.75	7.61 to 8.05	7.82	No Samples in 2013	

Table 7 – Summary of Groundwater Analyses – Inorganic and Other Selected Parameters, Cont.

PARAMETER	UNITS	GUIDELINE (1)	REGIONAL UP-GRADIENT (Well NRF-16)		EFFLUENT MONITORING (Well NRF-6)		SITE DOWN-GRADIENT (Wells NRF-8, 9, 10, 11, 12, & USGS-102)		REGIONAL DOWN-GRADIENT (Wells USGS-97, 98, & 99)	
			RANGE	MEAN (2)	RANGE	MEAN (2)	RANGE	MEAN (2)	RANGE	MEAN
Potassium	mg/L	(3)	2.6 to 2.8	2.7	6.5 to 6.6	6.6	<(5) 2.4 to 2.9	< 2.6	No Samples in 2013	
Selenium	mg/L	0.05	<< 0.0049	<< 0.0049	<< 0.0049	<< 0.0049	< 0.0049 to 0.0074	< 0.0051	No Samples in 2013	
Silver	mg/L	0.1	<< 0.00093	<< 0.00093	<< 0.00093	<< 0.00093	<< 0.00093	<< 0.00093	No Samples in 2013	
Sodium	mg/L	(3)	7 to 8	7	170 to 190	180	16 to 23	19	No Samples in 2013	
Specific Conductance	µmho/cm	(3)	375 to 378	377	1840 to 2010	1925	554 to 626	587	No Samples in 2013	
Sulfate	mg/L	250	21 to 23	22	87 to 100	94	31 to 41	35	No Samples in 2013	
Thallium	mg/L	0.002	<< 0.00005	<< 0.00005	<< 0.00005	<< 0.00005	< 0.00005 to <(5) 0.00027	<< 0.00008	No Samples in 2013	
Total Dissolved Solids (TDS)	mg/L	500	204 to 205	205	999 to 1091	1045	301 to 340	319	No Samples in 2013	
Zinc	mg/L	5	<< 0.0045	<< 0.0045	<< 0.0045	<< 0.0045	< 0.0045 to <(5) 0.0073	<< 0.0049	No Samples in 2013	

(1) Concentration guidelines from Code of Federal Regulations, Title 40, Part 141, National Primary Drinking Water Regulations, and Title 40, Part 143, National Secondary Drinking Water Regulations unless otherwise stated. Drinking water standards are used as a guide at NRF for monitoring groundwater, and are shown for comparison only.

(2) Mean values preceded by < contained at least one "less than minimum detection level" (MDL) value in the data set for that parameter. Mean values preceded by << contained all "less than MDL" values in the data set for that parameter and were the average of the MDLs. The same applies to range values preceded by < and <<.

(3) No guideline available per federal or state regulations.

(4) Action level for lead that requires treatment.

(5) This result was assigned a validation qualification code of "U" by the Data Validation Contractor, which means the value is considered to be less than the MDL. For the purposes of this presentation, the "U" qualifier is shown as "<" and is considered to be the same as the Analytical Laboratory's qualification code of "ND" not detected. As circumstances warrant, the qualifier "<<" was added to the mean value.

(6) The unfiltered water sample results (510 ppb) for iron in NRF-11 exceeded the secondary standard. However, filtered results (58 ppb) were well below the standard. These results indicate that a significant amount of the iron reported in the unfiltered samples is likely due to suspended solids and not due to NRF activities.

Table 8 – Summary of Groundwater Radioactivity Results

PARAMETER	UNITS	GUIDELINE	REGIONAL UP-GRADIENT (Well NRF-16)			EFFLUENT MONITORING (Well NRF-6)		
			MINIMUM[1]	MAXIMUM	MEAN[2]	MINIMUM[1]	MAXIMUM	MEAN[2]
Strontium – 90	pCi/L	8	< 0.08	< 0.16	<< 0.12 ± 0.13	< 0.01	< 0.24	<< 0.13 ± 0.14
Tritium	pCi/L	20,000	10.70	16.28	13.49 ± 0.52	20.30	22.55	21.43 ± 0.56
Cesium - 137	pCi/L	200	< -5.09	< 5.10	< 0.00 ± 49.53	< -3.16	< 0.00	<< -1.58 ± 4.80
PARAMETER	UNITS	GUIDELINE	SITE DOWN-GRADIENT (Wells NRF-8, 9, 10, 11, 12, & USGS-102)			REGIONAL DOWN-GRADIENT (Wells USGS-97, 98, & 99)		
			MINIMUM[1]	MAXIMUM	MEAN[2]	MINIMUM	MAXIMUM	MEAN
Strontium – 90	pCi/L	8	< -0.11	0.44[3]	< 0.09 ± 0.22	No Samples Collected in 2013		
Tritium	pCi/L	20,000	14.76	46.92	23.25 ± 0.42	No Samples Collected in 2013		
Cesium - 137	pCi/L	200	< -2.79	< 1.91	<< 0.39 ± 1.38	No Samples Collected in 2013		

(1) The instruments used in the laboratory to measure radioactivity in environmental media are sensitive enough to measure the natural (or background) radioactivity along with any contaminant radioactivity in a sample. To obtain a true measure of the contaminant level in a sample, the background radioactivity level is subtracted from the total amount of radioactivity measured by an instrument. When a larger background is subtracted from a smaller total radioactivity measurement, a negative result is generated.

(2) The (±) value represents the statistical error at two standard deviations for the mean.

(3) The validation contractor flagged this value as non-detected (<).

< Less than the MDC.

<< All results are less than the MDC.

4.5 SOIL GAS MONITORING

Soil gas data are collected as required by the CERCLA Remedial Action pertaining to the NRF Inactive Landfills (Sites 8-05-1, 8-05-51, and 8-06-53). (Figure 4).

The Remedial Action included a construction phase and an O&M phase. The construction phase consisted of the placement of landfill covers and the installation of soil gas monitoring probes around the perimeter of the landfill areas.

The O&M Plan requires that soil gas monitoring be performed to verify that the migration of subsurface gaseous volatile organic constituents away from the landfill areas is minimized. The O&M Plan also requires that soil gas monitoring include a soil gas emissions survey to assess the effectiveness of the landfill cover in limiting surface soil gas emissions.

SOURCES

The principal sources of the landfill soil gases are from residual Volatile Organic Compounds (VOCs) located in the buried waste at the three landfill areas. The minimum chemicals requiring monitoring in the soil are listed in Table 9. In accordance with standard industry practices in the past, various types of nonradiological wastes were disposed of in the three landfill areas. Based on employee interviews and historical records, these wastes primarily included construction debris, paper, cafeteria wastes, office debris, limited amounts of waste chemicals, petroleum based products, paints, paint thinner, and spent solvents.

Standard industrial waste disposal practices of the time were deposition of the waste at the landfill site, incineration of the waste contents, and burial. Site 8-05-1 was in operation from approximately the early 1950's until 1960. Site 8-05-51 was in operation during the late 1950's and early 1960's. Site 8-06-53 was in operation from approximately 1960 until the late 1960's. The locations of these landfill areas are depicted in Figure 4.

These sites are not accessible to the general public. During the early 1990s, a risk assessment was performed under CERCLA to determine the most hazardous constituents present in the landfills. The levels of these constituents detected during current sampling were comparable to the levels reported in the risk assessment. The risk assessment concluded that the levels for the target constituents did not present any significant risk to NRF personnel, the general public, or the environment. In addition, none of these constituents has been detected at the surface in past sampling evolutions.

MONITORING, ANALYSES, AND RESULTS

The soil gas samples were collected from permanent soil gas monitoring probes that are installed around the perimeter of each landfill area (Figure 4). An initial set of soil gas data was collected soon after the completion of the Remedial Action construction phase in October 1996. This data was used to determine whether the soil gas monitoring probes were functional and to serve as a baseline for all subsequent sample data obtained in support of the O&M phase of the Remedial Action.

The O&M sampling schedule dictates that soil gas samples from Site 8-05-1 will be collected on a semi-annual basis and soil gas samples from Sites 8-05-51 and 8-06-53 will be collected annually. The analysis of all the samples collected in 2013 was performed using the laboratory's analytical procedure, based on the EPA TO-15 analytical method. The soil gas data obtained in 2013 are presented in Table 10.

The specific VOCs that have been consistently detected at or above the sample quantitation limit during sampling are as follows: dichlorodifluoromethane (Freon-12), trichlorofluoromethane (Freon-11), chloroform, 1,1,1-trichloroethane, tetrachloroethylene (PCE), and trichloroethylene (TCE). In addition, 2-butanone was detected at several locations, and carbon disulfide and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-13) were detected at only one location.

Only PCE was consistently detected at all three landfill areas. In addition, PCE was detected at the highest concentration of all the VOC constituents detected. The maximum PCE concentration was detected at sample location MW1-4 at Site 8-05-1. However, the maximum PCE concentration for this sampling period did not exceed the maximum concentration detected during the previous CERCLA soil gas sampling conducted during the early 1990s.

In addition to the soil gas monitoring probe sampling, an annual soil gas emissions survey was conducted on the surface of the landfill soil covers at each landfill area using a portable Photo-Ionization Detector. This survey was conducted for the detection of PCE, since PCE was detected at the highest concentration of all the VOC constituents at all three landfills. The survey indicated no detectable levels of PCE at the surface of any of the landfills. This is consistent with past survey results.

SOIL GAS MONITORING CONCLUSIONS

The analytical results for this sampling period for the three NRF inactive landfills indicate that there were no significant increases in VOC levels in the surrounding environment. The landfills that contain low levels of VOCs from past operations continue to be adequately controlled and contained to minimize migration of those contaminants. The levels of VOCs present in the subsurface at the three landfills do not present any significant risk to NRF personnel, the general public, or the environment. Therefore, the results of the soil gas emissions survey verify that the landfill soil covers for all three landfills are effective in limiting surface soil gas emissions to the environment.

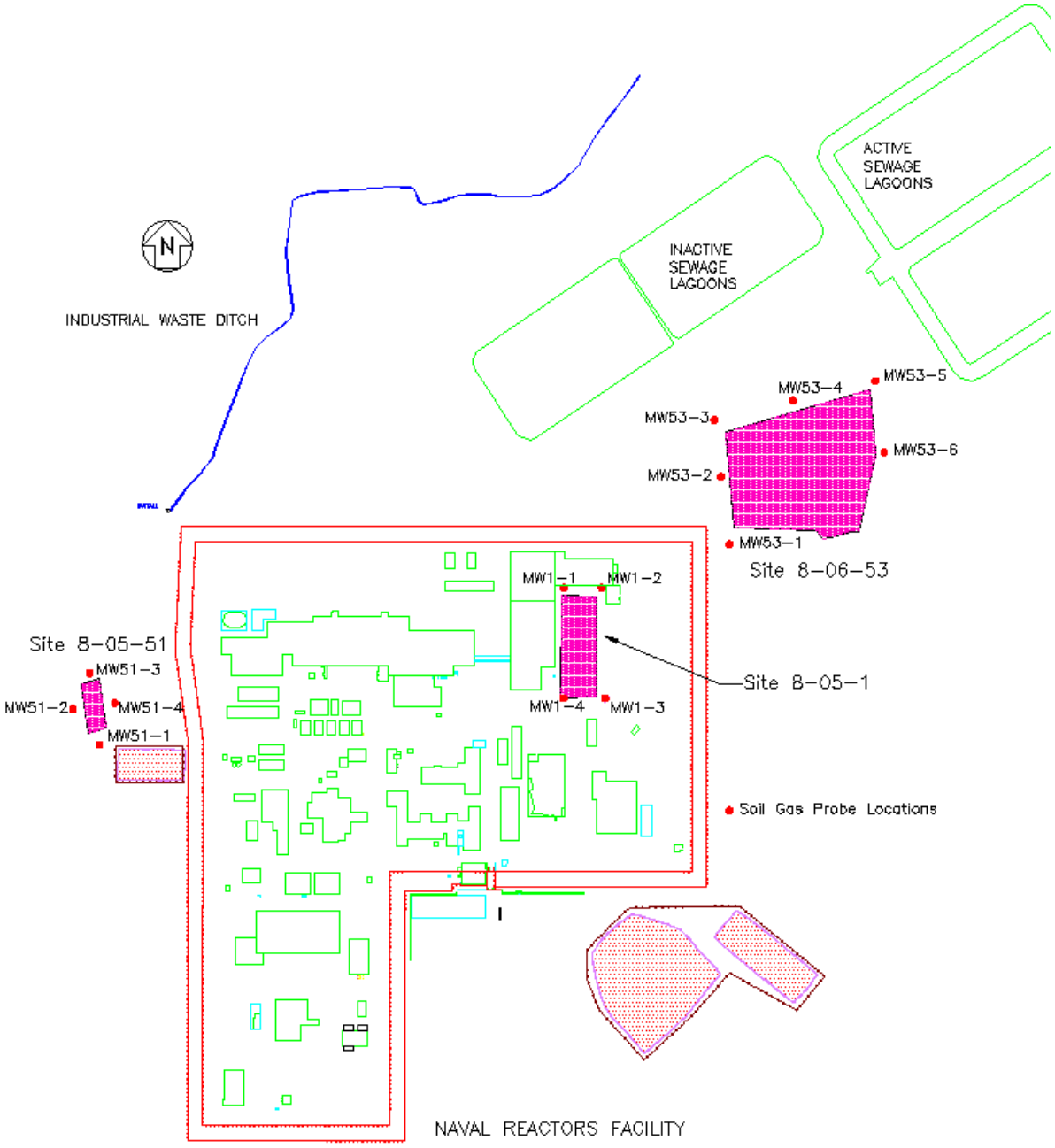

Figure 4 – Soil Gas Monitoring Locations

Table 9 – NRF Soil Gas Monitoring Minimum Target Parameters[1]

CHEMICAL	CRQLs (ppbv)[2]
Benzene	2
Carbon Tetrachloride	2
Chloroform	2
Dichlorodifluoromethane	2
1,1-Dichloroethane	2
1,2-Dichloroethane	2
1,2-Dichloroethylene	2
cis-1,2-Dichloroethylene	2
trans-1,2-Dichloroethylene	2
Ethylbenzene	2
Methylene Chloride	2
1,1,2,2-Tetrachloroethane	2
Tetrachloroethylene	2
Toluene	2
1,1,1-Trichloroethane	2
Trichloroethylene	2
Trichlorofluoromethane	2
1,1,2-Trichloro-1,2,2-trifluoroethane	2
Vinyl Chloride	2
Xylenes	2

(1) The chemical constituents and EPA's program Contract Laboratory Required Quantitation Limits (CRQL) for soil gas monitoring are as required in the CERCLA O&M Plan.

(2) The concentration may be expressed as ppbv (parts per billion based on the volume of contaminant in a sample per the total sample volume) or mg/m^3 (weight of the contaminant in a cubic meter of air). The laboratory typically reports the concentration of each constituent as ppbv but in much of the literature the concentration is expressed as mg/m^3, $\mu g/m^3$, or µg/L.

Table 10 – Summary of Soil Gas Monitoring Results[1][2]

Site/ Monitoring Probe ID	Trichlorofluoro-methane or Freon-11		Chloroform		1,1,1-Trichloro-ethane		Tetrachloroethylene or PCE		Trichloroethylene or TCE	
	RANGE µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3
OU 8-05-1										
MW1-1	4.3 – 9.0	6.6	8.8 – 13.6	11.2	1.7 – 5.3	3.5	12.9[3]	<QL	750.9 – 1179.9	965.4
MW1-2	6.2 – 9.0	7.6	<QL	<QL	2.5 – 3.3	2.9	24.4 – 29.8	27.1	2.3 – 4.0	3.1
MW1-3	6.7 – 9.0	7.9	3.2 – 4.0	3.6	4.5 – 5.3	4.9	1015.4 – 2301.6	1658.5	69.7 – 101.9	85.8
MW1-4	7.9[3]	<QL	4.3[3]	<QL	4.4[3]	<QL	3046.2 – 6024.8	4535.5	28.4 – 53.1	40.8
OU 8-05-51[4]										
MW51-1	12.9	N/A	4.5	N/A	6.53	N/A	67.7	N/A	<QL	N/A
MW51-2	12.3	N/A	5.4	N/A	7.08	N/A	67.7	N/A	2.79	N/A
MW51-3	7.9	N/A	<QL	N/A	4.03	N/A	47.4	N/A	<QL	N/A
MW51-4	10.1	N/A	2.0	N/A	3.05	N/A	<QL	N/A	<QL	N/A
OU 8-06-53[4]										
MW53-1	<QL	N/A	<QL	N/A	<QL	N/A	13.5	N/A	<QL	N/A
MW53-2	4.9	N/A	<QL	N/A	2.34	N/A	108.3	N/A	<QL	N/A
MW53-3	2.3	N/A	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW53-4	3.4	N/A	<QL	N/A	1.74	N/A	22.3	N/A	<QL	N/A
MW53-5	<QL	N/A	<QL	N/A	<QL	N/A	12.2	N/A	<QL	N/A
MW53-6	<QL	N/A	<QL	N/A	<QL	N/A	32.5	N/A	<QL	N/A

Table 10 – Summary of Soil Gas Monitoring Results[1][2] – Cont.

Site/ Monitoring Probe ID	Dichlorodifluoromethane or Freon-12		2-Butanone		1,1,2-Trichloro-1,2,2-trifluoroethane or Freon-13		Carbon Disulfide	
	RANGE µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3	**RANGE** µg/m^3	**MEAN** µg/m^3
OU 8-05-1								
MW1-1	<QL	<QL	4.1[3]	<QL	<QL	<QL	<QL	<QL
MW1-2	<QL	<QL	3.8[3]	<QL	<QL	<QL	<QL	<QL
MW1-3	<QL	<QL	<QL	<QL	<QL	<QL	<QL	<QL
MW1-4	46.4 – 79.0	62.7	<QL	<QL	3.4[3]	<QL	<QL	<QL
OU 8-05-51[4]								
MW51-1	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW51-2	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW51-3	<QL	N/A	4.7	N/A	<QL	N/A	<QL	N/A
MW51-4	<QL	N/A	<QL	N/A	<QL	N/A	5.6	N/A
OU 8-06-53[4]								
MW53-1	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW53-2	<QL	N/A	2.9	N/A	<QL	N/A	<QL	N/A
MW53-3	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW53-4	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW53-5	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A
MW53-6	<QL	N/A	<QL	N/A	<QL	N/A	<QL	N/A

(1) Range values preceded by < were "less than the sample quantitation limit" (QL) and are estimated values for those parameters. Range values designated as <QL only contained all "less than the sample quantitation limit" values in the data set for those parameters.

(2) The concentration may be expressed as ppbv (parts per billion based on the volume of contaminant in a sample per the total sample volume) or mg/m^3 (weight of the contaminant in a cubic meter of air). The laboratory typically reports the concentration of each constituent as ppbv but in much of the literature the concentration is expressed as mg/m^3, µg/m^3, or µg/L.

(3) Only one data point above the QL was obtained during the 2013 sampling period. As singular occurrences, no mean value was calculated.

(4) Sample locations sampled annually, therefore only one data point available when constituent was detected.

4.6 AIRBORNE EFFLUENT MONITORING

The purposes of the airborne effluent monitoring program are to determine the effectiveness of NRF's air pollution control methods and to measure concentrations of air pollutants released from NRF for comparison with applicable standards and natural background levels.

SOURCES AND TREATMENT

The principal sources of non-radioactive industrial pollutants at NRF are fuel combustion products from the three steam generating boilers. Diesel fuel oil is utilized in boiler operations and the resulting combustion products are released through elevated exhaust stacks. The boilers provide steam for heating buildings in the winter and are not used during summer months.

Other operations at NRF release small quantities of air pollutants. These sources include chemistry laboratories, facility maintenance operations, emergency power diesel generators, janitorial activities, and shops, which encompass activities such as painting, welding, and carpentry.

All of these sources contribute to particulate matter present in the ambient air. However, the primary sources of airborne particulate matter at NRF are naturally occurring windblown dust and then smoke from seasonal fires.

Friable asbestos that can become airborne is controlled at NRF. A long-term asbestos abatement plan was started in 1988 and completed in 1997. The purpose of this project was to reduce the amount of asbestos at NRF. This project removed approximately 31,450 linear feet of asbestos containing material (ACM) primarily in the form of friable pipe insulation. However, some asbestos still remains at NRF. The remaining ACM pipe insulation is inspected periodically to ensure that asbestos fibers are not being released to the environment. NRF has identified and labeled all remaining known asbestos-containing thermal insulation onsite. Small amounts of ACM have also been identified in floor tiles and mastic, ceiling tiles, drywall joint compound, fire resistive safes, and gasket materials. These materials are managed to prevent it from becoming friable and airborne in accordance with all applicable regulations.

Small quantities of airborne radioactivity are produced by radiological work at NRF. However, high efficiency particulate air (HEPA) filters and charcoal filters are used on appropriate exhaust stacks to reduce radioactive air emissions. In addition, naturally occurring radon present in the environment is also entrained in the exhaust air.

Fugitive radiological air emissions may arise from soils containing residual radioactivity from historic discharges in some areas. These areas were evaluated under the Comprehensive RI/FS. Fugitive soil emissions are conservatively calculated using soil sampling data generated by the soil and vegetation monitoring program. These areas are sampled on an annual basis to confirm the low levels of radioactivity. These areas are not accessible to the general public.

MONITORING, ANALYSES, AND RESULTS

NONRADIOLOGICAL

Emissions from fuel-burning equipment were calculated using EPA approved emission factors contained in Reference 5.

The type of diesel fuel oil consumed at NRF met the Air Quality Tier I Operating Permit requirements and is confirmed by vendor data certification records.

Total emissions for 2013, as defined by IDEQ, are presented in Table 11. These include: carbon monoxide (CO), nitrogen oxides (NO_x), lead (Pb), small particulate matter (PM_{10}), sulfur dioxide (SO_2), and volatile organic compounds (VOCs).

Air emissions from the three steam generating boilers were substantially reduced beginning in 1995 by burning American Society for Testing and Materials (ASTM) grade number 1, 2, and 4 diesel fuel oils and discontinuing the use of ASTM grade number 5 fuel oil. In addition, SO_2 emissions were significantly reduced in 2003 by purchasing low sulfur diesel fuel oil and again in July of 2006 by purchasing and using ultra-low sulfur diesel fuel oil. In 2013, NRF only received and burned ultra-low sulfur number 2 diesel fuel oil.

The INL calculates airborne concentrations of sulfur oxides and nitrogen oxides by using an air dispersion model. The air dispersion model accounts for meteorological conditions such as wind speed, wind direction, and rainfall when calculating average annual concentrations for air pollutants. The INL calculates the maximum average annual sulfur dioxide and nitrogen dioxide concentrations at the INL Site boundary from all INL primary sources including NRF. These values are reported in the annual INL site environmental report.

In addition, the INL Environmental Monitoring Program operates air monitors at the INL and the surrounding communities to determine the concentration of particulates in the air, as required by References 6 and 7. Concentrations are measured as PM_{10} and as total suspended particulates. The total suspended particulate and PM_{10} concentrations measured on the NRF site are reported in the annual INL Site Environmental Report. All concentrations were within their applicable regulatory requirements in 2013.

Visual emissions inspections of NRF point sources were performed quarterly in 2013. The Air Quality Tier I Operating Permit requires quarterly inspections of the point source emissions. Quarterly surveillances for fugitive dust sources were also conducted. No deviations from the permit condition were observed. NRF was determined to be in compliance with Reference 6.

In 2013, NRF's four emergency diesel generators were operated less than 20 hours each. Therefore, NRF was in compliance with applicable requirements. These emergency diesel generators fall under 40 CFR 63 Subpart ZZZZ, National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. Emergency stationary Reciprocating Internal Combustion Engines are exempt from most of these requirements. These requirements limit operational hours for maintenance and testing. However, emergency operations are not limited under these rules.

When work was performed at NRF that could result in airborne asbestos, sampling was performed in or near the worksite, and analyzed in accordance with National Institute for Occupational Safety and Health (NIOSH) analytical method 7400, "Asbestos Fibers by PCM" (Phase-Contrast Microscopy). In cases where there was a high potential for both asbestos and non-asbestos fibers, samples were taken and analyzed per NIOSH method 7402, "Asbestos by TEM" (Transmission Electron Microscopy). Samples were analyzed by an outside laboratory accredited by the American Industrial Hygiene Association.

Both area and personal monitoring samples have also shown that engineering controls in place were effective. NRF's ongoing air monitoring program has confirmed that workers in spaces containing asbestos materials were not exposed to asbestos fibers above regulatory limits. In addition, this sampling verified there were no measurable discharges of asbestos fibers to the environment. Therefore, all asbestos work performed at NRF was conducted in accordance with the applicable federal regulatory requirements.

RADIOLOGICAL

Airborne effluents from radiological areas at NRF were monitored for particulate radioactivity using fixed filter air samplers. These samplers drew air from each radiological area or stacks and deposited the particulate matter on filter papers. All filter papers were analyzed for gross alpha and gross beta activity and for gamma activity using a gamma spectrometer to identify specific gamma-emitting radionuclides. The concentration of these radionuclides in the exhaust air was determined based on the sample results. When airborne concentrations were above defined action levels, an investigation was performed to determine the cause. During 2013, concentrations of particulate radionuclides were below action levels except for one instance of high alpha activity caused by a weather inversion and one instance of high beta activity that was determined to have resulted from an anomaly in sampling methods rather than actual emissions.

A fixed filter air sampler is located at the NRF gatehouse to measure background levels of airborne radiological particulate. In addition, fixed filter air samplers are located to the north and to the south of NRF, to serve as upwind and downwind monitoring stations. These samplers measured ambient radioactivity levels at NRF for comparison with emissions from radiological areas.

There are two potential sources of tritium air emissions at NRF. One source is gaseous tritium resulting from nuclear fuel examinations in the ECF hot cells. The second source is tritium in the form of water vapor that is released from the NRF water pits. The water vapor tritium was sampled using molecular sieve cartridges. Tritium water vapor is also sampled from the outdoor air for background comparison.

The quantities of gaseous carbon-14, iodine-129, and krypton-85 radioactivity in the effluent air were calculated based on fuel handling operations and hot cell examination work. In addition, charcoal cartridges were used to sample for gaseous radioiodine in airborne effluent at ECF. These charcoal cartridges were replaced weekly and promptly counted using gamma spectrometry for quantitative identification. During 2013 no emissions of radioiodine were identified; all sample results were below Decision Level Concentrations.

Windblown dust radionuclide emissions from soil surrounding NRF were calculated using average wind velocities and data collected from soil sampling (see Soil and Vegetation Monitoring section). Cobalt-60 and cesium-137 have historically been found in the soil surrounding NRF, so they are the expected components of windblown dust. The total radioactivity in NRF air emissions during 2013 is listed in Table 12.

In 2013, a total effective dose equivalent of 0.00038 millirem per year from NRF air emissions was calculated for the maximally exposed members of the general public. This calculation was performed using the EPA approved computer model, CAP-88 (Reference 8). This dose is substantially below the radiation exposure limits of 100 millirem per year established by the Nuclear Regulatory Commission and the DOE (Reference 1 and 2). Further, it is negligible when compared to the naturally occurring background radiation dose of approximately 366 millirem per year calculated in southeast Idaho. It is also much less than the approximate 3 millirem that an individual would receive from a single cross-country airplane flight.

AIRBORNE EFFLUENT MONITORING CONCLUSIONS

NONRADIOLOGICAL

The results of NRF's airborne nonradiological effluent monitoring for 2013 have shown that air emissions from NRF did not exceed the applicable air quality standards set by the EPA and the State of Idaho. All asbestos removal work was completed in compliance with the applicable requirements. All workers were protected from exposure to asbestos, and there was no measurable discharge of asbestos fibers to the environment.

RADIOLOGICAL

The results of NRF's airborne radiological effluent monitoring for 2013 have shown that the amount of radioactivity released was too small to result in any measurable change in the background radioactivity levels in the environment. Therefore, the amounts of the particulate and gaseous radioactivity released from the NRF site during 2013 were well within the applicable standards for radioactivity in the environment. Furthermore, the estimated radiation dose to any member of the general public from the airborne radioactivity released was too low to measure and it was conservatively calculated to be significantly below the standard established by the EPA.

Table 11 – Nonradiological Air Emissions

Pollutant	Boilers[1] (ton/yr)	Emergency Diesel Generators[2] (ton/yr)
CO	1.2E+00	2.1E-01
NO_x	4.8E+00	7.7E-01
Pb	2.9E-04	2.2E-06
PM_{10}	5.6E-01	1.4E-02
SO_2	5.1E-02	3.5E-04
VOC[3]	4.8E-02	2.0E-02

(1) The values are totals for the three NRF boilers. Emissions of nitrogen oxides were limited to 37.13 tons per year for each boiler in both of the following permits which were in effect until February 6, 2013:

a. Air Quality Tier I/Title V Operating Permit; Permit Number T1-030520, dated June 28, 2005; most recently amended October 30, 2009 by Permit Number T1-2009.0114. This permit was replaced by Permit Number T1-2009.0148, issued February 6, 2013.

b. Idaho Nuclear Technology and Engineering Center, Nitrogen Oxide Sources Permit to Construct; Permit Number P-2011.0124; dated December 30, 2011.

(2) The values are for the four emergency diesel generators.

(3) The total includes only the pollutants reported to IDEQ for the Title V Emissions Registration.

(4) "VOC" emissions are non-methane total organic compound (NMTOC) emissions.

Table 12 – Radiological Air Emissions

Radionuclide[1]	Curies	Half-Life
Carbon-14	7.3E-01	5715 years
Cobalt-60 (fugitive soil)	5.1E-08	5.27 years
Cesium-137 (fugitive soil)	8.4E-05	30.07 years
Gross Alpha	2.9E-06	24,100 years [2]
Gross Beta	6.0E-05	28.78 years [3]
Tritium	1.7E-02	12.32 years
Iodine-129	3.8E-05	16 million years
Iodine-131	4.1E-06	8.02 days
Krypton-85	2.2E-02	10.76 years

(1) Limits for radiological air emissions are based on the committed effective dose equivalent. Refer to the Radiological Dose Assessment section for a comparison of radiological emissions with the dose limits.

(2) Based on plutonium-239.

(3) Based on strontium-90.

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4.7 SOIL AND VEGETATION MONITORING

NRF's soil and vegetation monitoring program has three purposes. The first is to verify that current NRF operations are not adding any measurable radioactivity to the environment surrounding the NRF site. The second purpose is to verify continued containment of the few areas around NRF known to contain residual low-level radioactivity from past operations. The third purpose is to provide data used to calculate windblown radiological air emissions.

SOURCES

In accordance with standard practices at the time, and in full compliance with existing regulations, water containing low levels of radioactivity was discharged to specific, defined areas on NRF property during past operations. This practice was discontinued in 1979 when onsite systems for recycling water containing trace amounts of radioactivity became operational.

There are a few localized areas of soil within NRF's area of responsibility (e.g., A1W and S1W Leaching Beds) which contain small amounts of residual radioactivity, principally cobalt-60 and cesium-137 from past operations. These areas are not accessible to members of the general public. These areas are sampled on a routine basis to verify that the radioactivity is not migrating.

As part of the remedial action under the NRF ROD for Operating Unit 8-08, engineered covers were placed over these areas as well as the placement of a chain link fence and signs around the perimeter. Adjacent to the S1W Engineered Cover area is the Old Sewage Basin area (that contained residual buried radioactively contaminated soil) where an engineered cover was also placed. These two areas are encompassed by a common fence and were combined to form one sampling area. In addition, the sampling area includes the Old Seepage Basin Pumpout Area that surrounds the Old Sewage Basin on three sides. This is an area where the radioactively contaminated contents of the Old Sewage Basin were pumped out to the surrounding desert around 1958.

MONITORING, ANALYSES, AND RESULTS

Soil and vegetation sampling is conducted in four sampling areas surrounding NRF: the NRF Perimeter Sampling Area; the Combined S1W Leaching Beds and Old Sewage Basin Engineered Covered Sampling Area; the Southwest Sewage Lagoon Sampling Area; and the A1W Leaching Bed Engineered Cover Sampling Area (Figure 5). In 2013, forty soil samples and forty vegetation samples were collected in the NRF Perimeter Sampling Area and the Southwest Sewage Lagoon Sampling Area.

Less than forty samples were collected in the Combined S1W Leaching Beds and Old Sewage Basin Engineered Cover Sampling Area and the A1W Leaching Bed Engineered Cover Sampling Area. Fewer samples were collected in these areas compared to past years (prior to 2011) using the following approach. If the randomly selected sample locations fell within the area where the engineered cover was constructed, the locations were not sampled because: 1) only clean soil was used in the construction of these engineered covers; and 2) the sample results from the engineered cover soil were all below the decision level concentration (non-detectable) over several years of sample collection. Instead, a radiation survey was performed over these sample locations within the cover areas to verify that they were at background levels. Therefore, soil and vegetation samples

were only collected if the sample locations were outside of the engineered cover areas and if the radiation survey within the covers indicated readings above background levels. This approach was implemented per the O&M Plan for the engineered cover areas.

All sample/survey locations were determined randomly from a grid coordinate system superimposed over each area. Soil and vegetation samples were collected from the southwest cell of the sewage lagoon complex. In the A1W Leaching Bed Engineered Cover Sampling Area and the Combined S1W Leaching Beds and Old Sewage Basin Engineered Cover Sampling Area, samples were collected from the areas immediately surrounding the covers. These inactive areas are the locations where residual radioactivity from past operations are known to have been discharged or had the potential to have been inadvertently discharged. In addition, soil and vegetation samples were collected from the surrounding NRF perimeter area to confirm that radioactivity was not migrating from known areas of residual activity or deposited downwind of emission points. The NRF sample collection areas are illustrated in Figure 5.

Analyses of all samples collected were performed using a gamma spectrometry system. Data collected from soil and vegetation sampling were evaluated to detect any changes in surface radioactivity levels. The results of the routine soil and vegetation sample analyses are summarized in Table 13.

For 2013, the maximum radioactivity detected from the soil samples was 4.3 picocuries per gram of cesium-137. This sample was collected from a location within the Southwest Sewage Lagoon Sampling Area. Based on previous sampling, this level of radioactivity has been detected sporadically within this area in the past. There was no detectable radioactivity in any of the vegetation samples. The results of the radiation survey performed within the Combined S1W Leaching Beds and Old Sewage Basin Engineered Cover Sampling Area and the A1W Leaching Bed Engineered Cover Sampling Area indicated no readings above background.

For comparison, the mean concentration of residual radioactivity associated with NRF operations in the soil and vegetation samples is less than the average concentration of naturally occurring potassium-40 in the same samples.

SOIL AND VEGETATION MONITORING CONCLUSIONS

NRF operations in 2013 did not contribute to any measurable increase in radiation levels to the soil and vegetation in the surrounding environment. The localized areas at NRF that contain low levels of residual radioactivity from past operations continue to be controlled and contained to prevent contaminant migration. This radioactivity does not present any significant risk to NRF personnel, the general public, or the environment.

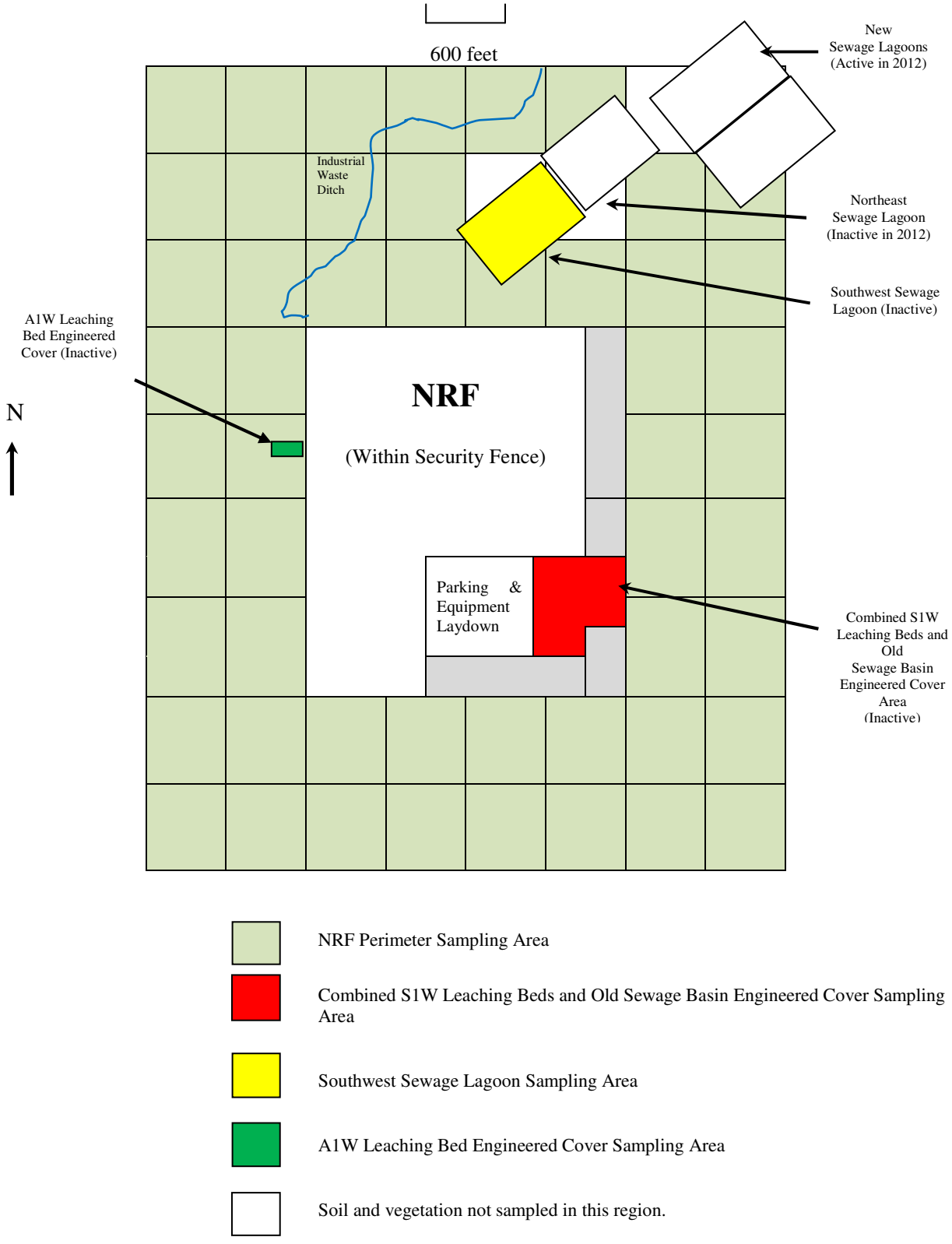

Figure 5 – NRF Soil and Vegetation Sample Collection Areas

Table 13 – Summary of Soil and Vegetation Gamma Radioactivity Results (pCi/gram Dry Weight)[1]

	Cobalt-60				Cesium-137			
	Soil		Vegetation		Soil		Vegetation	
Area	Range	Mean	Range	Mean	Range	Mean	Range	Mean
A1W Leaching Bed Engineered Cover (Inactive)	<DLC	NA	<DLC	NA	<DLC	NA	<DLC	NA
CombinedS1W Leaching Beds and Old Sewage Basin Engineered Cover Area (Inactive)	<DLC	NA	<DLC	NA	< 0.06 – 3.00	< 0.90	<DLC	NA
Southwest Sewage Lagoon (Inactive)	<DLC	NA	<DLC	NA	< 0.09 – 4.30	< 1.05	<DLC	NA
NRF Perimeter	<DLC	NA	<DLC	NA	< 0.10 – 2.90	< 0.40	<DLC	NA

(1) The < preceding the range values signifies the data were below the decision level concentration (DLC). The DLC varies due to the sample size, count time, and the background (natural) radioactivity at the time of analysis. Results that are less than DLC indicate that no radioactivity was detected by photopeak analysis. Because of the variance in the DLC, detectable activity reported for one sample can be lower than the DLC reported for another sample. Mean values preceded by < contained at least one "less than DLC" value in the data set for that parameter. No range is given and no mean values were calculated if all of the values in the data set were below the DLC.

4.8 CONTROL OF WASTES

During 2013, operations at NRF generated regulated wastes that fall into the following categories: asbestos, PCBs, RCRA hazardous, radioactive PCB, and mixed (radioactive and hazardous) wastes. All wastes are handled in accordance with the applicable federal, state, and local requirements. The generation of these wastes is minimized and controlled through the following practices.

ORIGIN

Operational and maintenance activities at NRF result in the generation of some RCRA hazardous wastes. These wastes primarily include heavy metal debris and laboratory wastes. Operations at NRF during 2013 also resulted in the generation of various types of low-level radioactive waste material, ranging from irradiated metal to paper and plastic products. Operations at the NRF site resulted in the generation of some mixed wastes. A "mixed waste" is a waste that contains both RCRA hazardous and radioactive constituents. These wastes included radioactively contaminated paint chips and heavy metal contaminated debris.

CONTROL PROGRAM

The waste management programs in place at NRF facilitate the minimization of the quantity of routine waste material generated, assure safe storage of the materials onsite, and provide for proper offsite disposal of wastes by vendors to federally and/or state permitted facilities.

A principal component of the overall control program is the review of purchase orders prior to the acquisition of chemicals at NRF. Purchase orders are reviewed to determine that the procurement of a hazardous material is necessary, to assure excessive quantities are not ordered, and to determine if a suitable nonhazardous substitute is available.

In 1992, a Chemical Management Program was developed, and a major revision to NRF's Waste Minimization and Pollution Prevention Program was completed. The Chemical Management Program was designed to track and control the volume and use of hazardous materials. This program additionally strengthens the control over procurement of hazardous materials. NRF maintains a Waste Minimization and Pollution Prevention program. NRF minimizes waste generation through source reduction, segregation, reuse and recycling. NRF reports waste minimization efforts in reports such as the Pollution Prevention Tracking and Reporting System. Combined, these programs provide additional controls for the use of hazardous materials and further reduce the generation of hazardous waste.

Appropriate training is provided to site personnel who handle hazardous materials to ensure that they are knowledgeable of safe handling techniques, emergency response procedures, and the use of Material Safety Data Sheets/Safety Data Sheets. Personnel were also provided training on workers' Hazard Communication and Right-to-Know Standards as defined in 29 CFR 1910.1200.

Waste generated from the use of hazardous materials is accumulated and stored in approved areas. These approved areas are managed in accordance with RCRA and State of Idaho hazardous waste regulations. Hazardous waste accumulation and storage areas are inspected routinely to verify that hazardous wastes are properly stored and controlled in accordance with approved work procedures and regulatory requirements.

The volume of radioactive waste generated at NRF is minimized by work-specific training programs, detailed work instructions, limitations of the amounts of material introduced to a radiological environment, and volume reduction programs.

All mixed wastes are managed in accordance with the State of Idaho hazardous waste regulations and the INL Site Treatment Plan that was implemented by a Consent Order signed by DOE and the IDEQ. This plan specifies the treatment and disposal methods for all of the INL, which includes NRF mixed wastes.

Since mixed wastes are both hazardous and radioactive, hazardous waste controls are applied to account for the hazardous constituents and radioactive controls are applied to account for the radioactive components at the point of generation.

The volume of mixed waste generated at NRF is minimized by work-specific training programs, review of detailed work instructions to remove hazardous chemicals where appropriate, engineering work to avoid generation of mixed waste, and volume reduction programs.

All PCB waste is managed in accordance with TSCA (40 CFR 761). PCB waste that contains RCRA hazardous constituents is managed utilizing both TSCA and RCRA controls. Radioactive PCB waste is managed employing both radiological and TSCA controls. Mixed PCB waste is managed in accordance with all three sets of requirements (RCRA, radiological, and TSCA).

DISPOSAL PROGRAMS

The amounts of waste disposed at NRF for 2013 are summarized in Table 14. The amounts of waste shipped for disposal include legacy wastes.

No hazardous wastes were disposed at the NRF site during 2013. All hazardous wastes generated by NRF were transported by contractors to EPA approved TSD facilities. The transportation vendors and the TSD facilities operate under the appropriate approvals or permits granted by federal and state regulatory agencies. NRF determines treatment and disposal methods in accordance with RCRA land disposal restrictions.

Since hazardous and mixed wastes generated at NRF were shipped directly to offsite TSD facilities, in 2013, NRF by-passed interim storage at the INL. This approach to waste management resulted in reduced costs. Non-hazardous and non-radioactive PCB wastes were disposed at an approved facility. Hazardous PCB wastes were disposed at TSD facilities approved to receive both hazardous and TSCA wastes.

Depending upon treatment and disposal services availability, hazardous and mixed wastes are either stored at NRF for less than 90-days or shipped to the INL TSD facility for temporary storage before they are shipped to offsite TSD facilities. Mixed PCB wastes can also be shipped to the INL TSD facility for temporary storage, pending treatment and disposal facility availability. Radioactive PCB bulk product and remediation wastes are disposed at an approved TSCA facility.

Beginning in 2009, certain radioactive wastes were transferred from NRF to the Idaho Nuclear Technology and Engineering Center (INTEC) for processing and certification as transuranic waste.

Shipment of these wastes from INTEC to the Waste Isolation Pilot Plant in New Mexico for final disposal began in 2011.

RECYCLING

During 2013, NRF continued to recycle as much waste material as practical. The recycling efforts at NRF are summarized in Table 15.

In 2013, NRF shipped radioactive recyclable metal to a vendor for recycling and reuse within the DOE program. Recycling of non-radioactive scrap metal is presently on hold, pending the lifting of a DOE Moratorium on recycling scrap metal released from radiological facilities.

NRF is also reducing the amount of mixed waste being sent for disposal by recycling heavy metal bearing equipment and radioactively contaminated elemental lead through a Navy contract with an approved out-of-state radioactive material recycling facility. This material is stored as recyclable until sufficient quantities are accumulated to justify a shipment. Shipping casks and other obsolete components containing lead shielding have been sent to the recycling facility for dismantling, meltdown, and recycling into shipping containers for radioactive material and into shield blocks.

Table 14 – Waste Disposal Amounts(1)

Type of Waste	Weight (lbs)
Hazardous Waste(2) (amount generated)	3,243
Low Level Radioactive Waste(3) (amount shipped)	110,819
Low Level Mixed Waste(4) (amount generated)	6,292
Municipal Waste(5)	12,848,397
PCB Waste (6)	194

(1) This table does not include items that were recycled.

(2) Hazardous waste category includes hazardous PCB waste and hazardous asbestos waste.

(3) Low level radioactive waste category includes radioactive PCB bulk product and PCB remediation waste.

(4) Low level mixed waste category includes radioactive, hazardous, PCB, and asbestos waste.

(5) This includes waste disposed of in the INL landfill and waste dispositioned at an approved RCRA facility (i.e. antifreeze, boiler ash, lab packs, and unused oil).

(6) PCB waste other than that which would be characterized as hazardous, radioactive, or mixed waste.

Table 15 – Recycling Amounts

Type of Material		Amount Recycled (lbs.)
Batteries		5,793
Cardboard		34,716
Clothing/Laundry		16,913
Computers/Cell Phones		6,992
Cooking Oil		1,320
Excess Chemicals		0
Heavy Metal Bearing Equipment		338,000
Lead	(Non-Rad)	2,295
	(Rad)	0
Light bulbs		514
Mercury Containing Devices		13
Phone Books		0
Scrap Metal	(Non-Rad)	254,276
	(Rad)	205,826
Tires		925
Toner Cartridges (Copier/Toner)		4,416
Oil (Used & Unused)		14,066
Wood		216,000

5 RADIOLOGICAL DOSE ASSESSMENT

The purpose of the radiation monitoring program is to verify that NRF operations do not increase radiation exposure to the general public.

MONITORING, ANALYSES, AND RESULTS

Measurement of radiation along the NRF perimeter was performed independently by NRF, INL, and Gonzales-Stoller Surveillance.

The NRF radiation monitoring program involves measuring ionizing radiation levels at 17 locations along the NRF security fence and eight other locations within the NRF property boundaries. Lithium-fluoride thermoluminescent dosimeters (TLDs) were placed at each location approximately three feet above the ground. These TLDs are calibrated to a known source value by the Naval Dosimetry Center. Figure 6 shows the locations of the 25 NRF TLDs posted along the NRF perimeter.

NRF also posted 15 TLDs (three groups of five) throughout the INL varying from five to ten miles from the NRF Site to determine INL radiation background levels. All NRF environmental TLDs were collected and processed quarterly.

The INL measured ionizing radiation levels at six points surrounding the NRF Site (Figure 6). This monitoring was performed by placing optically stimulated luminescence dosimeters (OSLDs) at each of the six pre-designated locations. The INL OSLDs were collected and processed following the twelve month monitoring period.

Gonzales-Stoller Surveillance independently measures natural background ionizing radiation levels at offsite locations under the DOE Offsite Environmental Surveillance program using TLD measurements obtained from 17 locations along the INL boundary and distant communities (Figure 7). DOE environmental TLDs were collected and processed every six months.

In addition to the TLD and OSLD network, any radiation surveys that were conducted around the NRF site perimeter used a highly sensitive radiation detection instrument.

The results of the radiation monitoring programs conducted by NRF, the INL, and Gonzales-Stoller Surveillance in 2013 are summarized in Table 16. A comparison of the average reading around the NRF perimeter and the average background reading measured by NRF at locations on the INL five to ten miles away indicates that NRF does not contribute to an increase in radiation levels. This is further verified by comparing the average NRF perimeter reading to the average reading of the DOE environmental TLDs posted along the INL boundary and distant communities.

Some TLD monitoring locations along the NRF perimeter were located near known individual sources of radiation and, as expected, recorded exposure higher than the natural background levels. None of these TLDs showed any notable increase in exposure compared to previous monitoring periods. Although these individual readings were higher than the NRF average environmental radiation level, the radiation levels were localized, administratively controlled, and do not contribute to increased radiation exposure to the general public.

Environmental monitoring results from 2013 did not reveal any measurable increase above naturally occurring radioactivity levels in the environment from NRF operations. Radiation exposure to the general public from NRF airborne emissions was too low to measure and could only be determined with conservative computer models based on the effluent radiological data. Therefore, an assessment of the radiation dose-to-man was performed by analyzing the exposure pathways whereby radioactivity might theoretically be transported from NRF to the general public. The following potential exposure pathways were considered in this assessment:

- Liquid Pathways: Ingestion of radioactivity in the drinking water supply.
- Airborne Pathways: Exposure as a result of radionuclide emissions to the air.
- Direct Exposure Pathways: Direct external radiation from NRF operations.

There is no potential for exposure to the public from liquid pathways because NRF did not discharge any radioactive liquid from operations in 2013. NRF drinking water radiological monitoring showed levels comparable to background concentrations measured in groundwater at the INL and significantly below federal and state drinking water limits.

The dose for each airborne exposure pathway was explicitly calculated for each radionuclide and its applicable daughter products. The total effective dose equivalent for airborne pathways was calculated using the EPA approved CAP-88 computer program described in Reference 8. The airborne pathway calculations used 2013 meteorological data collected by the National Oceanic and Atmospheric Administration.

Because the radiation levels at the NRF site boundary are low, and the site is removed from public access, there is no exposure to the public from direct exposure pathways.

RADIOLOGICAL DOSE ASSESSMENT CONCLUSIONS

The maximum total effective dose equivalent that a member of the public could have hypothetically received due to NRF operations in 2013 was 0.00038 millirem (Table 17). This dose is substantially below the radiation exposure limit of 100 millirem per year established by the Nuclear Regulatory Commission and the DOE (Reference 1 and 2). Further, it is negligible when compared to the naturally occurring background radiation dose of approximately 366 millirem per year calculated in southeast Idaho. It is also much less than the approximate 3 millirem that an individual would receive from a single cross-country airplane flight. Therefore, operations at NRF did not result in any measurable radiation exposure to the general public.

Based on computer modeling and direct sampling, NRF operations produced no measurable radiation exposure to the general public during 2013. Calculations included liquid, airborne, and direct exposure pathways.

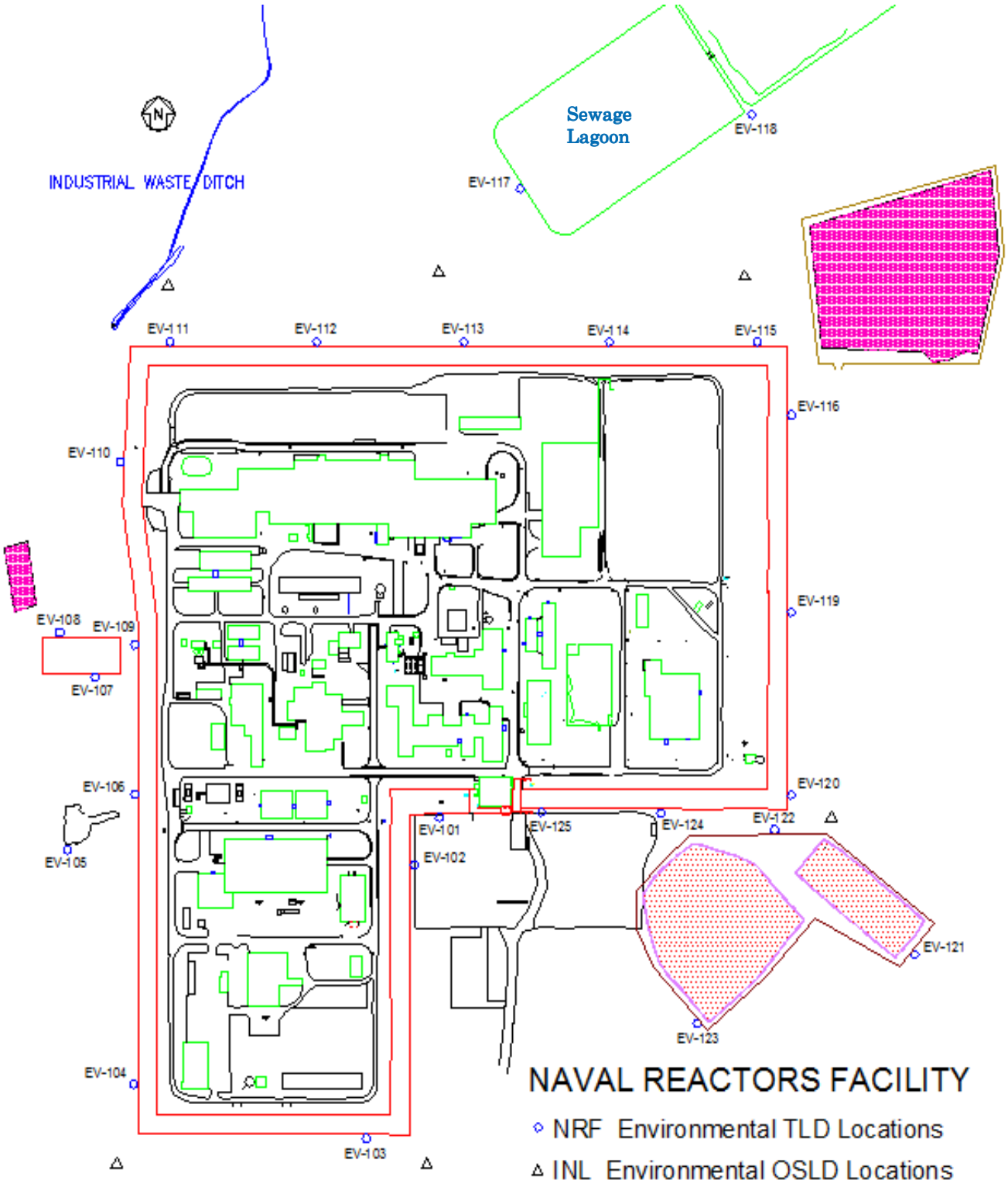

Figure 6 – NRF and INL Environmental Dosimeter Locations at NRF

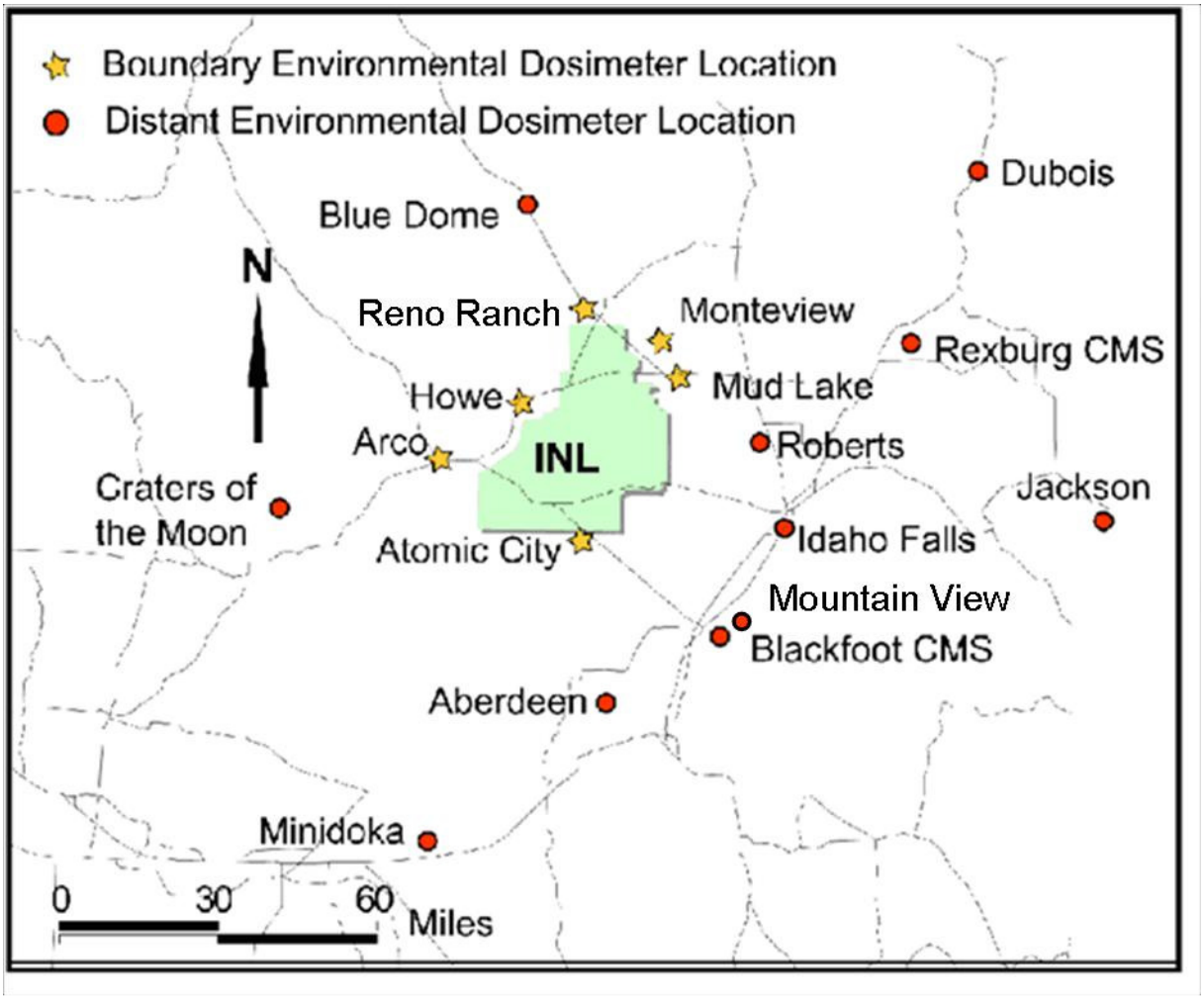

Figure 7 – DOE Offsite Environmental Surveillance Program Environmental Dosimeter Locations for INL Boundary and Distant Communities

Table 16 – Environmental Ionizing Radiation Measurements for NRF (millirem)

NRF Onsite Readings (91 day quarterly period)[3]					INL Readings of NRF Site (12 month period)[4]				NRF Readings of INL Background (Remote from NRF) (91 day quarterly period)[3]				Readings from INL Boundary and Distant Communities[2] (6 month period)[5]			
Quarter	Number of Measurements	Mean[1]	Max	Min	Number of Measurements	Mean[1]	Max	Min	Number of Measurements	Mean[1]	Max	Min	Number of Measurements	Mean[1]	Max	Min
1st	25	23 ± 3	26	20	6	133 ± 7	139	129	15	22 ± 2	24	20	17	60 ± 10	70	51
2nd	25	24 ± 3	27	22					15	25 ± 3	28	22				
3rd	25	23 ± 3	27	21					15	25 ± 3	27	22	17	65 ± 15	86	54
4th	25	26 ± 3	29	23					15	26 ± 3	28	24				

(1) The uncertainties given in the "mean" column represent a 95% confidence level.

(2) The INL boundary and distant communities monitored in Idaho included Aberdeen, Arco, Atomic City, Blackfoot, Blue Dome, Craters of the Moon, Dubois, Howe, Idaho Falls, Jackson, Minidoka, Monteview, Mountain View, Mud Lake, Reno Ranch, Rexburg, and Roberts. Offsite dosimeter readings are collected by Gonzales-Stoller Surveillance as part of the Offsite Environmental Surveillance program for the DOE at the INL.

(3) All readings are normalized in millirem for a 91 day quarter, the first quarter begins 01/03/2013 and the fourth quarter ends 01/03/2014.

(4) The twelve month period from 11/01/2012 to 10/31/2013. Readings reflect total time between anneal and processing.

(5) The first six month period from 11/01/2012 to 04/30/2013 and the second six month period from 05/01/2013 to 10/31/2013. Readings reflect total time between anneal and processing.

Note: The slight variations in the values were not significant and were due to the variables inherent in dosimetry processing, monitoring location, and dosimeter types used by NRF, the INL, and Gonzales-Stoller Surveillance radiation monitoring programs.

Table 17 – NRF Dose Table

Pathway	Dose to Maximally Exposed Individual (mrem)	% of DOE 100 mrem/yr Limit	Population within 80 Km	Estimated Background Radiation Population Dose (person-rem)
Air	0.00038	0.00038	1.57E5	5.75E4
Water	None	None		
Other Pathways	None	None		
All Pathways	0.00038	0.00038		

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6 QUALITY ASSURANCE

The NRF environmental monitoring program has an extensive quality assurance program plan which provides a detailed outline for data quality objectives, program organization, data and sample management, analytical procedures, program training and safety, audits, and data validation.

Each quality assurance program for offsite-subcontracted laboratories has been thoroughly reviewed by NRF. These quality assurance programs, in conjunction with existing NRF analytical quality assurance practices, provided the data validation to ensure accuracy in the radiological environmental monitoring program.

NRF also participates in the quality assurance programs of other government agencies that NRF uses to analyze samples. These programs were designed to test and demonstrate the on going consistency, precision and accuracy of laboratory techniques, and analytical results in relation to samples submitted by NRF. For example, the data generated by some of these agencies are forwarded to NRF in support of the groundwater monitoring programs.

As prescribed by specific analytical methodologies (e.g., SW-846), subcontracted analytical laboratories demonstrate the precision and accuracy of the nonradiological and radiological analyses by properly analyzing quality control samples. Quality control samples such as matrix spikes, duplicate samples, trip blanks, and field blanks are used to monitor sampling and analytical laboratory performance, as well as measure accuracy and precision. The vendor laboratories are not aware which samples are being used for quality control purposes. This allows NRF to discretely verify reported laboratory results.

NRF subjects environmental monitoring results to data validation processes to determine whether the data meet the quality control requirements and therefore are usable. Procedures used to validate data are based on EPA data validation guidelines. Items evaluated during validation include but are not limited to: checks on holding times, instrument calibrations, procedures used for analysis, blanks, control samples analyzed by the laboratory, method detection limits, and required quantitation and detection limits. An independent data validation firm validates the majority of the environmental monitoring data provided to NRF by subcontract laboratories.

During 2013, minor problems were noted with the laboratories used to analyze environmental samples. Problems included: high dilution factors, technician errors, hold times missed, and laboratory quality control problems. NRF worked with the appropriate laboratory program managers to resolve these problems. Samples were reanalyzed when possible, and new quality control measures were implemented where necessary to ensure confident sample results.

In addition, the Department of Energy's Consolidated Audit Program (DOECAP) audits offsite, subcontract laboratories used by NRF. This program utilizes trained and certified personnel to perform in-depth audits of subcontract laboratories. The program looks at a number of key elements including:

- Personnel training and qualification;
- Detailed analytical procedures;

- Calibration of instrumentation;
- Participation in an inter-comparison program;
- Use of blind controls; and
- Analysis of calibration standards.

Audit results are posted to the DOECAP website. Laboratories are required to provide corrective action plans for audit findings.

Finally, the NRF Chemistry Laboratory performs radiological measurements of soil, vegetation, liquid effluent, sediment, and air samples onsite at NRF. This internal laboratory participates in a quality assessment program sponsored by Environmental Resources Associates (ERA). Results of the inter-laboratory cross check program are presented in Table 18. The data demonstrates satisfactory NRF performance.

Table 18– NRF Performance in the Environmental Resource Associates (ERA) Quality Assessment Program

DATE	SAMPLE TYPE	ANALYSIS	NRF RESULT(1)	ERA ASSIGNED VALUE(1)	ACCEPTANCE LIMIT(1, 2)
MAR13	Air Filter	Cobalt-60	217	214	166 - 267
		Cesium-137	940	940	706 - 1,230
	Soil	Cobalt-60	7,945	7,920	5,360 - 10,900
		Cesium-137	6,083	6,120	4,690 - 7,870
	Vegetation	Cobalt-60	1,983	1,920	1,320 - 2,680
		Cesium-137	538	544	394 - 757
	Water	Cobalt-60	2,310	2,270	1,970 - 2,660
		Cesium-137	1,945	1,880	1,600 - 2,250
SEP13	Air Filter	Cobalt-60	511	494	382 - 617
		Cesium-137	618	602	452 - 791
	Soil	Cobalt-60	5,552	5,680	3,840 - 7,820
		Cesium-137	3,970	4,130	3,160 - 5,310
	Vegetation	Cobalt-60	1,732	1,880	1,300 - 2,630
		Cesium-137	914	1,030	747 - 1,430
	Water	Cobalt-60	1,892	1,890	1,640 - 2,210
		Cesium-137	2,680	2,760	2,340 - 3,310

(1) Units reported: Air = pCi/filter, Soil & Vegetation = pCi/Kg, Water = pCi/L.

(2) The acceptance limits are provided by ERA.

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7 RADIATION AND RADIOACTIVITY

This section provides general information on radiation and radioactivity for those who may not be familiar with the terms and concepts.

Man has always lived in a sea of natural background radiation. This background radiation was and is as much a part of the earth's environment as the light and heat from the sun's rays. There are three principal sources of natural background radiation: cosmic radiation from the sun and outer space, radiation from the natural radioactivity in soil and rocks (called “terrestrial radiation”), and internal radiation from the naturally radioactive elements that are part of our bodies. A basic knowledge of the concepts of radiation and radioactivity is important in understanding how effective control programs are in reducing radiation exposures and radioactivity releases to levels that are as low as is reasonably achievable.

7.1 RADIATION

In simple terms, radiation is a form of energy. Microwaves, radio waves, X-rays, light, and heat are all common forms of radiation. The radiation from radioactive materials (radionuclides) is in the form of particles or rays. During the decay of radionuclides, alpha, beta, and gamma radiation are emitted.

- Alpha radiation consists of small, positively charged particles of low penetrating power that can be stopped by a sheet of paper. Radionuclides that emit alpha particles include radium, uranium, and thorium.
- Beta radiation consists of negatively charged particles that are smaller than alpha particles but are generally more penetrating and may require up to an inch of wood or other light material to be stopped. Examples of beta emitters are strontium-90, cesium-137, and cobalt-60.
- Gamma radiation is an energy emission like an X-ray. Gamma rays have great penetrating power but are stopped by up to several feet of concrete or several inches of lead. The actual thickness of a particular shielding material required depends on the quantity and energy of the gamma rays to be stopped. Most radionuclides emit gamma rays along with beta or alpha particles.

Each radionuclide emits a unique combination of radiations that is like a "finger print" of that radionuclide. Alpha or beta particles and/or gamma rays are emitted in various combinations and energies. Radionuclides may be identified by measuring the type, relative amounts, and energy of the radiations emitted. Measurement of half-life and chemical properties may also be used to help identify radionuclides.

7.1.1 RADIATION DOSE ASSESSMENT

Body tissue can be damaged if enough energy from radiation is absorbed. The amount of energy absorbed by body tissue during radiation exposure is called "absorbed dose". The potential biological effect resulting from a particular dose is based on a technically defined quantity called "dose equivalent". The unit of dose equivalent is called the rem. Another quantity called "effective dose equivalent" is a dose summation that is used to estimate health-effects risk when the dose is

received from sources that are external to the body and from radioactive materials that are within the various body tissues. The unit of effective dose equivalent is also the rem. As will be seen from the following discussion, the rem unit is relatively large compared with the level of doses received from natural background radiation or projected as a result of releases of radioactivity to the environment. The millirem (mrem), which is one thousandth of a rem, is frequently used instead of the rem. The rem and mrem are better understood by relating to concepts that are more familiar.

The National Council on Radiation Protection and Measurements estimates that the average member of the population of the United States receives an annual effective dose equivalent of approximately 311 mrem from natural background radiation. This is composed of approximately 33 mrem from cosmic radiation, 21 mrem from terrestrial radiation, 29 mrem from radioactivity within the body, and 228 mrem from inhaled radon and its decay products. The cosmic radiation component in the United States varies from 22 mrem at Honolulu, Hawaii to 65 mrem in Colorado Springs, Colorado. The terrestrial component varies about 10 mrem on the Atlantic and Gulf Coastal Plain to about 40 mrem in the mountainous regions of the west. The dose from inhaled radon and its decay products is the most variable because of fluctuations in radon concentrations within houses due to changes in weather patterns and other factors such as changes in living habits.

The average natural background radiation level measured in southeast Idaho is approximately 366 mrem per year. Individual locations will vary based on soil composition, soil moisture content, and snow cover.

In addition to natural background radiation, people are also exposed to man-made sources of radiation, such as medical and dental X-rays rays and conventional fluoroscopy, computed tomography, nuclear medicine, and interventional fluoroscopy. The average radiation dose from these sources is about 300 mrem per year. Other man-made sources include consumer products, such as building products (brick and concrete), lawn and garden fertilizer, loose-leaf spinach and bananas. An airplane trip results in increased radiation exposure. A round-trip flight between the east and the west coast results in a dose of about 5 mrem.

7.2 RADIOACTIVITY

All materials are made up of atoms. In the case of a radioactive material, these atoms are unstable and give off energy in the form of rays or tiny particles in order to reach a stable state. Each type of radioactive atom is called a radionuclide. Each radionuclide emits a characteristic form of radiation as it gives off energy. Radionuclides change as radiation occurs, and this transition is called radioactive decay. The rate at which a particular radionuclide decays is measured by its half-life. Half-life is the time required for one-half the radioactive atoms in a given amount of material to decay. For example, the half-life of the man-made radionuclide cobalt-60 is 5.3 years. This means that during a 5.3 year period, half of the cobalt-60 atoms initially present will have decayed. In the next 5.3 year period, half the remaining cobalt-60 atoms will have decayed, and so on.

The half-lives of radionuclides differ greatly. The half-life of naturally occurring radon-220, for instance, is only 55 seconds. In contrast, uranium-238, another naturally occurring radionuclide has a half-life of 4.5 billion years.

Through the decay process, each radionuclide changes into a different nuclide or atom, often becoming a different chemical element. For example, naturally occurring radioactive thorium-232,

after emitting its radiation, transforms to a second radionuclide, which transforms to a third, and so on. Thus, a chain of eleven radionuclides is formed including radon-220, before non-radioactive lead-208 is formed. Each of the radionuclides in the series has its own characteristic half-life and type of radiation. The chain finally ends when the newest nuclide is not radioactive. The uranium chain starts with uranium-238 and proceeds through 13 radionuclides, ending with stable lead-206. All of these naturally occurring radionuclides are present in trace amounts in the soil in your backyard as well as in many other environmental media.

7.2.1 MEASURING RADIOACTIVITY

The curie (Ci) is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to work with conveniently and is broken down into smaller values such as the microcurie (μCi), which is one millionth of a curie (10^{-6} curie) and the picocurie (pCi), which is one trillionth of a curie (10^{-12} curie). The typical radium dial wristwatch has about one microcurie (μCi) of radium on the dial. The average person has about one tenth (0.1) microcurie of naturally occurring potassium-40 in his body. Typical soil and sediment samples contain about one picocurie of natural uranium per gram.

7.2.2 SOURCES OF RADIOACTIVITY

Of the radioactive atoms that exist in nature, some have always existed and natural processes continually form others. For example, uranium has always existed, is radioactive, and occurs in small but variable concentrations throughout the earth. Cosmic radiation striking atoms in the atmosphere, on the other hand, form radioactive carbon and tritium. Radionuclides can also be created by man. For example, they are created in nuclear reactors and consist of fission products and activation products. The fission products are the residues of the uranium fission process that produces the energy within the reactor. The fission process also produces neutrons that interact with structural and other materials in the reactor to form activation products. Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of "background" fission product radioactivity also exists in the environment, primarily due to past atmospheric nuclear weapons testing. Although the level is very low, these fission products are routinely detected in air, food, and water when analyzed with extremely sensitive instruments and techniques.

7.3 CONTROL OF RADIATION AND RADIOACTIVITY

To reduce to as low as is reasonably achievable the exposure of persons to ionizing radiation, controls on the use and disposal of radioactive materials and comprehensive monitoring programs to measure the effectiveness of these controls are required. Effluent streams that may contain radioactive materials must be treated by appropriate methods to remove the radioactive materials and the effluent monitored to ensure that these materials have been reduced to concentrations that are as low as is reasonably achievable and are well within all applicable guidelines and requirements.

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8 GLOSSARY

Activation Product – As cooling water circulates through the reactor, certain impurities present in the water and even components of the water itself can be converted to radioactive nuclides (they become "activated"). Important activation products present in reactor coolant water include radionuclides of corrosion and wear products (cobalt-60, iron-59, cobalt-58, chromium-51), of impurities dissolved in the water (argon-41, sodium-24, carbon-14) and of atoms present in the water molecules (tritium). Of these, the predominant radionuclide and also the one with the most restrictive limits is cobalt-60.

Alkalinity – The measurable ability of solutions or aqueous suspensions to neutralize an acid.

Alpha Radioactivity – A form of radioactivity exhibited by certain radionuclides characterized by emission of an alpha particle. Many naturally occurring radionuclides including radium, uranium, and thorium decay in this manner.

Aquifer – A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.

Background Radiation – Radiation present in the environment as a result of naturally occurring radioactive materials and cosmic radiation. Generally treated as including widespread low-level human-made radiation sources, including fallout.

Beta-Gamma Radioactivity – A form of radioactivity characterized by emission of a beta particle and/or gamma rays. Many naturally occurring radionuclides such as lead-212, bismuth-212, and bismuth-214 decay in this manner.

Calibration – The adjustment of a system and the determination of system accuracy using known sources and instrument measurements of higher accuracy.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Also known as "Superfund," CERCLA was enacted by Congress in 1980 to clean up inactive hazardous waste sites that presented great risk to public health and the environment.

Composite sample – A sample of environmental media that contains a certain number of sample portions collected over a period of time, or at the same time from multiple nearby locations. The sample portions may or may not be collected at equal time intervals over a predefined period of time (e.g., quarterly).

Conductivity – A measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in water and the temperature at which the measurement is made.

Confidence Interval – Statistical terminology for the error interval (±) assigned to numerical data. A 2σ (σ, the lower case Greek letter "sigma") confidence interval means there is 95% confidence

that the true value (as opposed to the measured one) lies within the (±) interval of the measured value. The 95% is the confidence level. (See (±) value, Standard Deviation of the Average).

Contaminant – Any physical, chemical, biological, or radiological substance in a location or concentration that is not naturally occurring.

Corrosion and Wear Product – Piping and the components used in construction of a nuclear reactor are fabricated from extremely durable, corrosion, and wear resistant materials. Even under the best circumstances, however, small amounts of these materials enter the reactor cooling water due to wear of moving parts and corrosion of the water contact surfaces of reactor plant components. While in no way affecting operational characteristics or reactor plant integrity, some of these corrosion and wear products may become activated as they pass through the reactor core. This necessitates that the reactor coolant be processed by filtration or other methods of purification before it is discharged or reused. (See Activation Products).

Curie (Ci) – The curie is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to conveniently work with and is broken down to smaller values. (See Microcurie and Picocurie).

Data Validation – A systematic review of a data set to identify outliers or suspect values. More specifically, data validation refers to the systematic process of independently reviewing a body of analytical data against established criteria to provide assurance that the data are acceptable for their intended use. This process may use appropriate statistical techniques to screen out impossible or highly unlikely values.

Decision Level Concentration (DLC) – The minimum value of the measured analyte concentration that provides a degree of confidence that a detectable amount of analyte is present in the material analyzed. The DLC varies due to the sample size, count time, and the background (natural) radioactivity at the time of analysis. Results that are less than the DLC indicate that no radioactivity was detected by photopeak analysis.

Dose Equivalent – The quantity that expresses the biological effects of radiation doses from all types (e.g., alpha, beta-gamma) of radiation on a common scale. The unit of dose equivalent is rem.

Down-gradient – Referring to the flow of groundwater, down-gradient is analogous to downstream and is a point that is "after" an area of study that is used for comparison with up-gradient or upstream data.

Duplicate Sample – A sample that is created by splitting existing samples before analysis and treating each split sample as a separate sample. The samples are then analyzed as a quality assurance method to assess the precision in the analytical process.

Field Blank – A sample of laboratory distilled water that is put into a sample container at the field collection site and is processed from that point as a routine sample. Field blanks are used as a quality assurance method to detect contamination introduced by the sampling procedure.

Fission Product – During operation of a nuclear reactor, heat is produced by the fission (splitting) of "heavy" atoms, such as uranium, plutonium or thorium. The residue left after the splitting of these "heavy" atoms is a series of intermediate weight atoms generally termed "fission products." Because of the nature of the fission process, many fission products are unstable; i.e., radioactive. Most fission products have short lives and are retained with the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant. It should be noted that a certain level of "background" fission product radioactivity exists in the environment, primarily due to atmospheric nuclear weapons testing. The level is very low, but is generally detectable when environmental samples are analyzed with extremely sensitive instruments and techniques.

Fugitive Air Emission – Any air emission that goes directly to the air, rather than out a stack or vent or other engineered emission point.

Grab Sample – A single sample that is collected and is representative of the stream or effluent.

Greenhouse Gas (GHG) – Air compounds, which include carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Half-Life – A value assigned to a radionuclide that specifies how long it takes for one-half of a given quantity of radioactivity to decay away. Half-lives may range from fractions of a second to millions of years.

High Efficiency Particulate Air (HEPA) Filter – A throwaway, extended-media, dry type filter with a rigid casing enclosing the full depth of the pleats. The filter shall exhibit a minimum efficiency of 99.97% when tested at an aerosol diameter of 0.3 micrometers aerodynamic diameter.

Long-Lived Gamma Radioactivity – Two very important characteristics of radionuclides are the length of time it takes for a given amount to decay away and the type of radiation emitted during decay. From an environmental standpoint, some of the most significant radionuclides are those whose "half-life" is relatively long and that also emit penetrating gamma radiation during decay. Two radionuclides of concern in these respects are cobalt-60 (a corrosion and wear activation product) and cesium-137 (a fission product). (See Half Life, Beta-Gamma Radioactivity.)

Mg/L (Milligrams per liter) – A unit of concentration commonly used to express the levels of impurities present in a water sample. A milligram is a thousandth of a gram. A milligram per liter is equal to a part per million.

Microcurie (μCi) – One millionth of a curie (10^{-6} curie). The typical radium dial watch might contain 1 μCi of radioactive material. (See Curie and Picocurie.)

Millirem (mrem) – One thousandth of a rem (10^{-3} rem).

Minimum Detectable Concentration (MDC) – Depending on the sample medium, the smallest amount or concentration of a radioactive or non-radioactive analyte that can be reliably detected using a specific analytical method.

Optically Stimulated Luminescence Dosimeter (OSLD) – A sensitive monitoring device that records accumulated dose due to radiation. These dosimeters derive their name from a property that the material exhibits when exposed to radiation and subsequently stimulated with light from a laser or light-emitting diode. The material, when stimulated with light, emits a secondary amount of light within a specific frequency range that is proportional to the amount of radiation exposure received.

Outfall – A point of discharge (e.g., drain or pipe) of liquid effluent into a stream, river, ditch, or other water body.

Polychlorinated biphenyl (PCB) – Halogenated aromatic hydrocarbons formed by the chlorination of biphenyl molecules. PCBs were commonly used in transformers as dielectric fluid because of their stability and low electrical conductivity and in paint because of their fire resistance.

Person-Rem – The sum of the individual dose equivalents or effective dose equivalents received by each member of a certain group of population. It is calculated by multiplying the average dose per person by the number of persons within a specific geographic area. For example, a thousand people each exposed to 0.001 rem would have a collective dose of one person-rem.

pH – A measure of the acidity or alkalinity of a solution on a scale of 0 to 14 (low is acidic, high is alkaline or caustic, 7 is neutral).

Picocurie (pCi) – One trillionth of a curie (10^{-12} curie). Typical soil and sediment samples contain approximately one pCi of natural uranium per gram, and similar levels of many other natural radionuclides. (See Curie and Millicurie).

± Value (plus or minus value) – An expression of the error in sample results. The magnitude of the (±) value depends on the number of samples, the size of the sample, intrinsic analytical errors and the degree of confidence required. The (±) value assigned to data in this report is for the 95% confidence level. (See Confidence Interval).

Primary Maximum Contaminant Level (PMCL) – Federal and state primary drinking water standards that are enforceable limits regulating toxic contaminants in drinking water.

Quantitation limit – The lowest level at which a chemical may be accurately and reproducibly quantified. The sample quantitation limit is typically three to five times higher than the analytical method detection limit.

Radionuclide – Atoms that exhibit radioactive properties. Standard practice for naming radionuclides is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt). There are several hundred known radionuclides, some of which are man-made and some of which are naturally occurring. Radionuclides can be differentiated by the types of radiation they emit, the energy of the radiation, and the rate at which a known amount of the radionuclide decays away (half-life).

RCRA (Resource Conservation and Recovery Act) – A federal law that established a structure to track and regulate hazardous wastes from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous

substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites. RCRA particularly addresses chemical issues; Atomic Energy Act regulated radioactivity is exempted from RCRA.

Rem – The unit of dose equivalent and effective dose equivalent.

Secondary Maximum Contaminant Level (SMCL) – Federal and state secondary drinking water standards that are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water.

Short-Lived Gamma Radioactivity – Radioactive material that decays with a relatively short half-life and that also emits penetrating gamma radiation during decay. It is generally not important with respect to environmental discharges because of the short life span. Some examples of short-lived gamma emitting radionuclides are argon-41 (an activation product gas), krypton-88 (a fission product gas), and xenon-138 (a fission product gas).

Suspended Solid – Particulate matter, both organic and inorganic, suspended in water. High levels of suspended solids not only affect the aesthetic quality of water by reducing clarity, but may also indirectly indicate other undesirable conditions present. The analysis for suspended solids is performed by passing a sample of water through a filter and weighing the residue.

Thermoluminescent Dosimeter (TLD) – Sensitive monitoring devices that record accumulated dose due to radiation. The TLDs used by NRF for environmental monitoring consist of small chips of lithium fluoride (LiF) encased in appropriate materials and strategically located at site perimeter and offsite locations. Thermoluminescent Dosimeters derive their name from a property that LiF exhibits when exposed to radiation and subsequently heated – that of emitting light proportional to the amount of radiation exposure received (thermoluminescence). The emitted light can then be read out on special instrumentation and correlated to the amount of radiation dose accumulated. The TLDs used by NRF for environmental monitoring are specially selected for their accuracy and consistency of results.

Total Dissolved Solids (TDS) – Total Dissolved Solids is used as a general indicator of water quality. As the name describes, TDS tests measure the amount of all dissolved solids in the water. These solids are primarily minerals/salts, but can also include organic matter.

Up-gradient – Referring to the flow of groundwater, up-gradient is analogous to upstream and is a point that is "before" an area of study that is used as a baseline for comparison with down-gradient or downstream data.

Volatile Organic Compound (VOC) – An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

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9 REFERENCES

(1) DOE Order 458.1, Radiation Protection of the Public and Environment.

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(3) Gonzales-Stoller Surveillance, LLC, Environmental Surveillance Education and Research Program, September 2013, Idaho National Laboratory Site Environmental Report Calendar Year 2012.

(4) IDAPA 58.01.08, Idaho Department of Environmental Quality, “Idaho Rules for Public Drinking Water Systems.”

(5) AP-42, Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, Sections 1.3, 1.5, 3.3 and 3.4.

(6) IDAPA 58.01.01, Rules of Department of Environmental Quality, Title 1, Chapter 1, "Rules for the Control of Air Pollution in Idaho."

(7) Code of Federal Regulations, Title 40 Part 50 and 63.

(8) Clean Air Act Assessment Package - 1988 (CAP-88) - A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air, PC Version 3.0.

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